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A Comparative Study of Coho Salmon Populations of S. E. Vancouver Island, British Columbia: Juvenile Outmigration, Coded-Wire Tagging and Recovery, Escapement Enumeration, and Stock Composition at Black Creek, Trent River and French Creek, 1984-1988.

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ABSTRACT

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An investigation was initiated on Vancouver Island in 1984, to determine the degree of similarity between populations of coho salmon, in terms of their biological attributes and exploitation patterns. This report describes the various field investigations, estimation procedures and results obtained at Black Creek, Trent River and French Creek during the 1984-1988 period.

Juvenile trapping operations were conducted at each site from 1985 to 1987. Actual counts and estimates of total smolt output from each stream are presented. A substantial portion of each population was coded-wire tagged. Information on the outmigration pattern, age structure, demographic traits, fry survival, and the degree of similarity between populations is provided for most cases.

Adult enumeration was conducted at each location using a semi-permanent collapsible fence. In all cases, only a partial enumeration of each run through the fence was possible. Mark-recapture programs were conducted in all streams to estimate total escapement. Abundance estimates were generated from a sequential Bayesian algorithm developed recently for closed populations, and from an innovative open population model described in this report. Estimates from both models are compared, and recommendations are made for future improvements.

Coded wire tag recovery was conducted at each location to determine the stream of origin, and estimate exploitation rates. A substantial portion of the Trent River escapement consisted of hatchery strays. By contrast, very few strays were found in other systems. Information is presented on the upmigration pattern of each adult population, as well as its age, sex, size and spawning stock composition. The current status of each stock is discussed, in terms of their respective levels of productivity. Finally, several comments are made on means of improving similar stock assessment surveys conducted in the future.

RÉSUMÉ

Labelle, M. 1990. A comparative study of coho salmon populations of S. E. Vancouver Island, British Columbia: Juvenile outmigration, coded-wire tagging and recovery, escapement enumeration and stock composition at Black Creek, Trent River and French Creek, 1984-1988. Can. Tech. Rep. Fish. Aquat. Sci. 1722: 148 p.

Une investigation a été initié en 1984 sur l'île de Vancouver pour déterminer le degré de similarité entre les populations de saumons coho en terme d'attributs biologiques et de taux d'exploitation. Ce rapport d'écrit les investigations en milieu, les méthodes d'estimation, et les résultats obtenus à Black Creek, Trent River et French Creek, durant la période de 1984 à 1988.

Les opérations de capture des juveniles ont été conduites à chaque location entre 1985 et 1987. Les estimés du nombre de tacons observés et actuels produits par chaque rivière sont présentés pour chaque année. Une portion substantielle de chaque population a été étiquetée par micromarques magnetisées codées. Les résultats préliminaires sont présentés sur l'ampleur de migration journalière, la répartition d'âges, les traits démographiques, le taux de survivance, et le degré de similaritée entre populations pour la plupart des cas.

Le dénombrement des adultes a été conduit à chaque location au moyen d'une cloture semi-permanente élevable. Dans chaque cas, un dénombrement complet n'a pas été possible. Un programme de marquage et de recapture a été conduit dans chaque rivière pour déterminer l'échappement d'adultes. Les estimés d'échappement ont été produits au moyen d'un algorithme Bayesien développé récemment, ainsi que par l'entrimise d'un modèle pour population ouverte conçu spécialement pour la situation présente. Les estimés produits par chaque méthode sont comparés, et quelques recommendations sont présentés.

La collection des micromarques parmis les adultes a été faite dans chaque rivière pour déterminer l'origine des adultes capturés, ainsi que leur taux d'exploitation. Une portion substantielle de l'échappement à Trent River provenait de frayères. Par contraste, très peux de poissons de frayère ont été détectés dans les autres rivières. Des données sont présentées sur l'ampleur de la migration journalière des adultes dans chaque cours d'eau, ainsi que la composition de chaque population en terme d'age, de sexe, de largeur, et en d'origine. Mention est faite de l'état courant de chaque population en terme de taux de production. Finalement, quelques commentaires sont faits en fin d'améliorer les recensements similaires conduits dans le future à chaque endroit.

1.0 INTRODUCTION

In order to effectively manage stocks of Pacific salmon (*Oncorhynchus spp.*), it is essential that the escapement levels, fishery contributions, and stock-recruit relationships of various stocks be determined. There are approximately 1000 populations of coho salmon (*Oncorhynchus kisutch*) in British Columbia, which are harvested jointly at many locations on the coast (Aro and Shepard 1967). Monitoring each population on a continuing basis to obtain the required statistics represents a formidable, expensive and impractical task. This situation created a need for an alternative, cost-effective method of stock assessment.

One simplifying approach has been to partition a given area into sub-areas, and within each of these, use one population or unit as representative of others in the area. This is essentially the idea which lead to the development of the indexing approach, which is increasingly being used for management purposes (ODFW 1981; Cousens et al. 1982; Symons and Waldichuk 1984, Walters 1984, Hourston 1985). The same approach is also to obtain estimates of the exploitation patterns, ocean survival and marine distribution of certain populations. For instance, reference is often made to an 'indicator stock' when drawing inferences about the exploitation of coho and chinook populations from a given area. Once it has been determined that a certain population (or indicator stock[1]) is subject to a 50% harvest rate in a given fishery, it is assumed that other populations in the same region are also harvested in the same fishery at the same rate (Anon. 1983).

The use of the 'indicator stock' approach assumes that populations in close proximity behave as a single population in terms of their susceptibility to exploitation. However, in the absence of comparable statistics on the patterns of exploitation of neighboring coho populations, the validity of the hypothesis remains a matter of conjecture. As a result, the exploitation patterns of hatchery and non-hatchery coho populations are being subject to preliminary investigations (for instance Schubert and Lister 1986). Still, it remains to be demonstrated that certain population attributes within local assemblages can induce significant differences in exploitation.

Given the lack of adequate information on this issue, and the potential merits of the 'indicator stock' approach, an investigation was initiated in 1984. The primary objectives of this study were to:

A. determine the degree of similarity between proximal coho populations in terms of demographic traits and exploitation patterns;

B. identify the population attributes which influence their exploitation patterns;

C. determine the nature and number of populations that could be considered as a single unit for management purposes; and

D. provide a basis for the selection of an 'indicator stock' within the area studied.

In order to meet these objectives, it was essential that reliable information on the biological traits and fishery contributions of each stock be available. In a preliminary study, Walters (1984) suggested that regional groups of populations exploited in the same mixed-stock fisheries be used for indexing studies. Based on a series of criteria, Walters (1984) identified populations in DFO

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[1] In the present report, the term stock will refer to a distinct group of coho which departed as smolts from a stream on a given year, and which differ (phenotypically or genetically) from another group in the same or adjacent stream. Thus the coho population from a given stream can contain members of 2 stocks, such as fish of hatchery origin (transpanted as fry) and of non-hatchery origin (progeny of wild spawners).

statistical areas 13 and 14 as good candidates for conducting such studies. In those areas, several salmon hatcheries already have production and enumeration facilities. In addition, historical escapement estimates and coded-wire tagging information is available for a variety of populations. For the present study, eight streams on the east side of Vancouver Island (Fig. 1.1) were selected based of their respective geographical location, productivity levels, hydrological regimes, availability of logistic facilities and exposure to enhancement activities.

The systems chosen consist of the Quinsam River, Black Creek, Puntledge River, Trent River, Rosewall Creek, Big Qualicum River, Little Qualicum River and French Creek. Associated with these streams, a total of 13 stocks were used as experimental groups. All stocks were subject to coded wire tagging (CWT) and escapement enumeration.

In the absence of facilities for enumerating adults and juveniles, fences were built for such purposes at Black Creek, Trent River and French Creek. This report documents the field operations, sampling methods, survey techniques and preliminary results obtained at Black Creek, Trent River and French Creek, during the 1984-1988 period. Various analyses were conducted to provide descriptive and comparative statistics on the juvenile populations and their outmigration patterns, the adult escapement patterns, spawning levels, and the stock compositions of each population. Stock-specific data are presented jointly within each section to facilitate inter-stock comparisons. Information on the exploitation patterns of these stocks will be given in future reports as CWT recovery data becomes available from the Mark Recovery Program (MRP) database (Kuhn *et al.* 1988).

2.0 DESCRIPTION OF STUDY SITES AND SALMON POPULATIONS

2.1 BLACK CREEK

Black Creek is a small stream on the east coast of Vancouver Island, approximately 30 km north of Courtenay (Fig. 2.1). The physical features of the stream and particular attributes of its salmon population have previously been described by Hamilton (1978), Hancock and Marshall (1985), and Bocking *et al.* (1988). The following description is based on field surveys conducted by the author, as well as information obtained from these reports.

Black Creek is 26 km long, with a stream width of 5-6 m at midsection. The watershed area is approximately 72.5 hectares. The creek begins in the higher elevations of Mount Washington, and flows in a northeasterly direction to Alma Bay, in the Strait of Georgia. The intertidal section near the mouth consist of a narrow, short (< 0.5 km), and relatively flat channel with sand and mud substrates, little logging debris and some aquatic vegetation. The creek varies from a steep gradient mountain stream at higher elevations, to a sluggish meandering creek flowing through agricultural land and swamps, with dense overgrowth of wild rose, salmonberry and trees. In the lower reaches, the creek includes small lakes, swampy depressions, beaver pounds and several tributaries (Millar, Kelland, Surgenor and Sayer Creeks). Bank erosion, undercutting, scouring and silting are nearly absent along most of the middle and upper reaches, but is quite common in the lower sections. Throughout the creek, the streambed is composed mostly of a mixture of sand, silt and clay. Peak discharge is known to reach 60 $m^3 \cdot s^{-1}$ during fall and winter floods after a heavy rainfall. During summer, stream flow may decrease to negligible levels and cause some sections in the lower reaches to be completely dry.

The stream supports resident and anadromous populations of cutthroat *Salmo clarki*, and rainbow trout *Oncorhynchus mykiss* (Smith and Stearley 1989), as well as a considerably larger population of coho salmon. For its size, Black Creek is recognized as an exceptionally good coho producer. During the 1974-1984 period, escapement levels have been reported to reach 8,400 coho, but fishery officers reported nearly twice this figure in some years prior to 1975.

Hamilton (1978) noted that upstream migration at Black Creek is governed by the arrival of fall rains. In some years, insufficient flow delayed upstream migration considerably, inducing substantial fish mortality at the mouth in tidewaters (250 in 1974), and prevented access to spawning grounds in headwaters. Hamilton indicated that upstream migration occurred as early as October 3, and as late as November 9, during the 1969 to 1976 period.

A fence was first constructed near the mouth of the river in 1968, and a partial escapement enumeration indicated that at least 4656 coho entered the creek. This fence was refurbished in 1972, and operated intermittently by B.C Fish and Wildlife. A larger fence was installed in 1975, and fence counts showed escapement levels of 9492 coho, of which 20.5% were jacks[2]. Partial counts in 1976 showed escapement levels of at least 3,510 coho (% jacks = ?), and 199 trout.

Escapement enumeration was also conducted by DFO personnel from 1978 to 1980. Escapement levels during this period ranged from 800 to 7600 adults, and from 550 to 1200 jacks (Clark and Irvine 1989). Juvenile production during 1978 and 1979 was estimated at about 48,000 smolts. Two tag codes were used each year to identify smolts captured prior to and after the peak outmigration period. Tag codes 022039 (pre-peak) and 021653 were applied in 1978, and codes 022059 (pre-peak) and 022061 were applied in 1979. Scale samples showed that over 97% of the outmigrants were of age 1+.

Hamilton (1978) reported a considerable loss of spawning habitat in the stream since the early 1960's. Logging activities, habitat loss due to land development, and low summer flows induced by the seasonal lack of rainfall and increased agricultural water demands, were assumed to seriously affect the rearing capacity of the system. During the late 1980's, coho were still spawning throughout the creek, but most of the spawning activity was in Millard Creek, in areas adjacent to the Kelland and Sturgess road bridges, and in the upper reaches of the stream near the Duncan Main logging road (Jack Trent, pers. comm.).

So far, there has been no attempt to conduct substantial enhancement activities, in part because the escapement levels are still considered adequate. However, in recent years, there has been a series of small fry releases into the stream to determine the survival rate of coho fry in certain habitats (Table 2.1). Given the suspected low survival rate associated with previous fry releases, and the relative magnitude of the wild fry population, the vast majority of smolts outmigrating are considered to be of wild origin.

2.2 TRENT RIVER

The Trent River begins in the Beaufort mountain range, and flows in a northeasterly direction until it connects to the Strait of Georgia, near Royston just south of Courtenay (Fig. 2.2). The physical features of this river, and particular attributes of its salmon population have previously been described by Hancock and Marshall (1985), and Bocking *et al.* (1988). The

[2] Small, mature coho, which return to spawn after a relatively short period of marine life (< 9 months).

following description is based on field surveys conducted by the author, as well as information obtained from these reports.

The total length of the system, including several tributaries in the upper reaches, is approximately 30 km. The main section of the river is 9 km in length, with an average width of 16 m at mid-section. The intertidal section of the river is approximately 1 km long and 30 m wide, with sand flats, rocky outcrops, some logging debris and aquatic vegetation. This area is located at the periphery of the Comox harbor, a two-layered estuarine system (Morris *et al.* 1979), which receives the waters of the Puntledge and Tsolum Rivers.

Seven kilometers from the sea, Bloedel Creek connects to the mainstem, but this tributary is inaccessible to fish because of a series of falls and cascades in its lower section. One kilometer upstream from this junction, several falls prevent fish from reaching the upper sections of the river, including its two tributaries; Tremain Creek and Idle Creek.

Steep and high banks with very little overgrowth are found along the main section of the river. Throughout most of this area, cover is mainly in the form of logging debris, and is particularly abundant in the 2 km section above the river mouth. The river bed is composed mostly of bedrock with rocky outcrops and boulders. Along the middle reaches of the river, spawning substrate is scarce, and usually consists of shale material. In the lower reaches, spawning substrate is more abundant and consist of gravel, cobble and and shale deposits.

Seasonal fluctuations in water levels are pronounced, and large floods are common particularly during the winter period. Peak discharge is known to reach 150 $m^3 \cdot s^{-1}$ during fall and winter months, causing extensive gravel movement, log jam shifts, and scouring in the lower reaches. During the late summer, flows usually decrease to negligible levels, and several sections in the lower reaches dry up completely.

Because of the lack of cover, spawning substrate, and rearing habitat, the system is not recognized as a good coho producer. In fact, escapement records from fishery officers show greater abundance of chum than coho. During the 1974-1984 period, coho escapements rarely exceeded 350 fish (max. 1000), while those of chum salmon reached 3000 fish. The river also served as spawning grounds for a small number of pink salmon (3 to 150), and an unknown number of rainbow trout. It should be emphasized that the escapement figures reported have not been validated due to the lack of an adult counting facility prior to 1985.

Coho spawning activity has been reported throughout the system, but the major spawning grounds are located in the lower 2 km of the river, and in the lower section of China Creek. Chum salmon spawn mainly in the lower section of the river, between the mouth of the river and the railroad bridge.

Attempts have been made to enhance coho and rainbow trout by stocking the mainstem, as well as Bloedel Creek and Bradley Lake. In order to facilitate local enhancement efforts, a small hatchery was built near Courtenay in 1979. The hatchery is operated on a volunteer basis mainly by members of the Courtenay Fish and Game Club, and funded by the DFO's Salmonid Enhancement Program (SEP). The water source of this hatchery consists of ground water provided mainly by Morrison Creek and Bevon Creek, two tributaries of the Puntledge River. Since 1981, volunteers and SEP personnel have collected brood stock, reared the fry to various stages, and released them in several sections of the Trent River. The available records show that a variety of brood stocks have been used for enhancement purposes (Table 2.2). Marked fry were released mainly for habitat assessment, while unmarked fry were released for enhancement purposes. Given the lack of characteristic fin clips, the majority of these outplanted fry are not readily distinguishable from wild fry in samples collected during the juvenile tagging. In the

absence of reliable information on the historical abundance of wild smolts, and on the fry survival rates associated with most releases, it is not possible to accurately assess the success of the enhancement program prior to this study.

2.3 FRENCH CREEK

French Creek begins in the eastern slopes of Mount Arrowsmith, and flows northeasterly until it reaches the Strait of Georgia, north of Parksville (Fig. 2.3). The physical features of the system, and particular attributes of its salmon population have been described by Hancock and Marshall (1985), Johnston *et al.* (1987), and Bocking *et al.* (1988). The following description is based on field surveys conducted by the author, and some information obtained from these reports.

The creek is approximately 20 km long and 12 m wide at midsection. The intertidal section is approximately 1 km long, 100 m wide, and characterized by the presence of several small channels meandering through mud flats, with gravel and algal growth at the periphery. A large marina, and several stores are located adjacent to the mouth of the creek.

Several small falls exist in the mainstem section from 7 to 13 km upstream from the estuary. A rudimentary fishway was constructed in 1961 to facilitate the upstream migration, but insufficient discharge and debris build-up often prevent the fish from using it. Above the fishway, 12.5 km from the estuary, the creek bifurcates into two major sections. Most of the West fork is inaccessible to the fish because of 12 m high falls located 400 m upstream from the confluence. The East fork meanders for a few kilometers, and then splits into numerous small tributaries scattered among the logging zones.

This creek is characterized as having many pools, large seasonal fluctuations in water levels, some erosion and bank undercutting. Peak discharges of up to 15 $m^3 \cdot s^{-1}$ have been recorded during winter months. During the late summer, flows usually decrease to negligible levels, and several sections in the lower reaches become completely dry. Extensive gravel movement has been observed in the lower reaches of the creek, which are characterized by relatively soft banks, and a streambed of bedrock, boulders and cobble.

French Creek is characterized by an abundant vegetation cover and a relatively low gradient. As a result, the stream was recognized as a good coho producer, with escapement reaching up to 3500 coho during the 1974-1984 period. Chum salmon also spawn in the river, but fishery officer records indicate that escapement declined during this period to a maximum of 250 fish. Coho spawn throughout the system, but the major spawning grounds are located near the fork junctions, and adjacent to Winchester Road in the upper reaches of the system.

During the last decade, intensive logging near the headwaters, urbanization in the watershed, and reduced summer flows due to high demands are suspected to have had detrimental effects on the coho population (R. Hurst[3], pers. comm.). Since 1986, substantial fry mortality has been observed each summer, induced presumably by the low flow conditions. An attempt to enhance the coho and rainbow populations was initiated in 1982 with the construction of a small hatchery on Miller Road. The hatchery is operated mainly on a volunteer basis by members of the Qualicum-Parksville Fish & Game club, with some financial assistance and logistic support provided by SEP. Since 1985, club volunteers have collected brood stock from the creek, and have raised the fry for subsequent release into the creek. The available records show that only

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[3]Special Projects Division, SEP/DFO. Nanaimo, B.C.

adults of French Creek origin were used as brood stock for enhancement purposes (Table 2.3). Marked fry were released mainly for habitat assessment, while unmarked fry were released for enhancement purposes. Given the lack of characteristic fin clips, the majority of these outplanted fry were not readily distinguishable from wild fry in samples collected during juvenile tagging. However, a preliminary assessment of the survival rates of the marked fry released can be made based on the information obtained during the present study.

3.0 JUVENILE TRAPPING AND TAGGING OPERATIONS

3.1 INTRODUCTION

Downstream smolt traps (Conlin and Tutty 1979) have been shown to be effective in capturing smolt migrants, and were used in the present study for juvenile enumeration and tagging purposes. Specifications concerning fence construction and trapping methods followed those outlined in Conlin and Tutty (1979), although some modifications were required to strengthen the structure, increase trapping efficiency, and adapt the fence to local conditions. In the following sections, a brief description is given of the fence designs, trapping methods, tagging procedures, and results obtained at each location.

3.2 TRAPPING AND TAGGING METHODS

Fence and trap design

The structure of each fence comprised several large panels (1 m x 2.5 m) consisting of wooden frames made of clear grade wood (5 cm x 10 cm) divided into 3 sections. Each rectangular panel was covered by galvanized wire mesh screen with 1 cm^2 openings. Completed fence panels were joined to form a 'V' or 'W' configuration across the stream. Such configurations allow each 'wing' of the fence to block the current at an angle of less than 35° to minimize hydraulic pressure on each panel and increase trapping efficiency.

At each joint, panels were supported by pieces of steel rebar driven into the substrate, with wooden back braces for added structural strength. Flood gates were built into several sections of the fence. These consisted of hinged panels which could be opened manually at critical times. Flood gates also facilitated cleaning operations, and could be opened to allow passage of adult trout if necessary.

At the downstream apex(es) of each fence, a trap was used to collect and hold captured smolts. Each trap was composed of rectangular boxes (2 m x 1 m x 1 m) made of plywood sheets braced externally by angle sheet metal. Internal baffles were placed inside each box minimized exposure of trapped smolts to inflow turbulence. Several windows, covered externally by galvanized wire mesh screen and internally by soft nylon netting, were built on the sides of each box to allow sufficient water circulation. Usually, 2 to 4 boxes were joined together to form a complete trap. The size and configuration of the passage linking each box was adjusted to separate

the large trout from the smaller smolts, in order to reduce the number of injuries, the amount of scale loss, and the level of stress on the smolts.

A complete trap was connected to the apex(es) of the fence by means of a semi-rigid plastic pipe some 20 cm in diameter. Smolts concentrating at the downstream end of the fence usually seek holes to escape, and easily get funnelled into the pipe intake leading to the trap. Adjustments for variation in flows was done mainly by controlling the vertical angle of the pipe as it connects to the trap. Captured smolts were prevented from returning upstream by positioning the pipe at least 20 cm above the waterline in the trap, and by partially blocking the outflow with nylon screen. At each trapping site, up to 6 holding boxes were installed near the smolt trap to contain all fish captured.

Location of trapping sites

Preliminary field surveys identified potential sites for fence locations on the basis of relative flow rates, stream width, geomorphological characteristics and accessibility. Final decision regarding fence location was made in conjunction with local authorities and DFO fishery officers.

At Black Creek, the site chosen was approximately 0.5 km from the mouth of the creek, within the Miracle Beach Park, adjacent to the road leading from the Highway 19 to the Miracle Beach Resort. The smolt trap was positioned approximately 20 m downstream from the bridge, with the holding boxes and tagging platform located adjacent to the old concrete abutments. This site is located beyond tidal reaches, has a stream width of 16 m, and a streambed composed of small rocks, cobble and gravel. This site was also used in previous juvenile trapping operations (Clark and Irvine, 1989)

At Trent River, fences and traps were constructed approximately 400 m upstream from the Trent River bridge on Highway 19. At this location, the mainstem splits into several channels around two small islands, which lie beyond tidal reaches. The presence of numerous channels required the construction of 2 fences, each operated independently as a function of the flow rates in each channel. At these locations, channel widths ranged from 20 to 50 m, with a streambed characterized by an unstable and uneven mixture of rocks, cobble and fine gravel. Substantial efforts were made to prepare each site to accommodate the fence and stabilize the streambed.

At French Creek, the site chosen was behind the French Creek hatchery on Miller Road, approximately 1.5 km from the river mouth. This site lies beyond tidal reaches, has a stream width of approximately 20 m, and a streambed is composed of gravel, cobble and small rocks.

Installation and operation of smolt traps

Prior to the actual installation of the fence, the streambed along the path of each wing was flattened, graded, and covered with a 1 m wide sheet of polyethylene, held in place by a row of sandbags. This eliminated the gaps under the base of the panels, and helped to reduce hydraulic scouring of the streambed. The panels were then positioned, and nailed to one another in a straight line to distribute the water pressure evenly across each wing. As the wings were assembled, a continuous row of sandbags was placed along the base of each panel. All gaps between the sandbags were filled with gravel, and then covered with rocks. This prevented the rapid erosion of the sandbags, and ensured that smolts did not try to escape through the holes in the burlap. Once the fence and trap wee in position, all holding boxes were installed downstream from the fence, and anchored with steel rebar. Usually, all traps were in operation by late April.

Once installation was complete, each fence was monitored and maintained on a daily basis by at least 1 worker for the duration of the outmigration period. Field crews worked on site during most daylight hours. During peak migration periods, times of flooding and high water levels, field crews maintained surveillance periodically throughout the night.

During the enumeration, the fence was inspected for damage and if necessary, repairs were made immediately. Predators and injured fish (if any) were removed and noted. Passage of adult salmonids and other species through the fence was facilitated and recorded. Debris build-up was adjusted if necessary to improve the trapping efficiency and minimize fish injury. Juvenile salmon caught in the trap were transported to holding boxes if excessive loading was apparent. Field crews also monitored environmental conditions and provided assistance to other ongoing DFO investigations.

Tagging and sampling

Coded-wire tags (CWT, Jefferts *et al.* 1963; Jewell and Hager 1972) were applied exclusively to juvenile coho salmon exhibiting smolting characteristics (Wedemeyer *et al.* 1980), and exceeding 7 cm in fork length. Tags were implanted with a Mark II injector unit from Northwest Marine Technology. Tag retention was verified by means of a Quality Control Device (QCD) supplied by the same company. Each year, 2 to 4 distinct tag codes were used to identify each smolt population. These were alternated periodically throughout the tagging process so that approximately equal number of smolts were tagged with each code. The number of smolts tagged each day in a given stream was determined by the catch levels, the available manpower, predetermined tagging quotas, and the necessity to spread the tagging effort throughout the season as much as possible.

Tagging and fin clipping was performed by an experienced tagger and 3 assistants, using a semi-permanent marking platform installed near the trapping site. This platform supported the tagging unit, QCD, anaesthetic and recovery basins. The basins consisted of ten 1 plastic containers, covered with soft nylon net to minimize scale loss and facilitate handling. Tricane Methane Sulfonate (MS 222) was used in May 1985 to anesthetize the fish, but was substituted afterwards for 2-Phenoxyethanol, which appeared to be less toxic and easier to regulate.

Captured coho smolts were held in live boxes until sufficient numbers (≥ 300) had accumulated to allow tagging to proceed. Captured smolts were always tagged within 36 h after capture. Tagging began by transporting smolts to the marking platform in a 20 l bucket. Small numbers of smolts (≤ 30) were transferred from the bucket to the anaesthesia basins. All fish other than coho smolts were removed, identified, recorded, and released immediately downstream from the trap. Coho smolts exhibiting excessive scale loss (>10%), disease, or injuries were recorded and released without tags.

At the beginning of each tagging session, appropriate head molds and needle depths were determined. The first few smolts tagged were dissected, and if tag emplacement corresponded to that of the preferred depth, tagging proceeded. As soon as smolts exhibited disorientation (roll-over) and reduced activity, the adipose fin was removed. Each smolt was then oriented into the head mold, tagged, funnelled through the QCD, and diverted to a separate container for recovery.

During the tagging period, the water in each basin was changed every 15 minutes to maintain oxygen levels, replace the anaesthetic solution, and remove the mucus, scales, debris and fin pieces from the basins. Additional oxygenation or aeration was not judged to be necessary. Throughout the tagging period, adjustments were made to the tagging unit if the smolts exceeded the size range associated with the head mold/needle depth combination used.

Once all the smolts of one tag group had been tagged, the untagged fish rejected by the QCD were examined and retagged if necessary. All tagged smolts were then allowed to recover for 6 to 12 h prior to release. All tagged smolts were allowed to passively leave the recovery boxes through an opening after sunset on the day of tagging. This procedure did not impose any additional handling stress on the fish, and allowed them a few more hours to recover before reaching the estuary.

After each tagging session, a random sample of 50 to 200 tagged smolts was kept overnight to check for the tag retention rate. Although it is recommended that tag loss be measured approximately 4 weeks after tagging (Blankenship 1988), all tag retention checks in the field were done within 24 h. The constraints imposed by holding juveniles at the smolt stage, under field conditions, at relatively high water temperatures and high densities, dictated this approach.

In order to minimize the mortality levels acting upon each population, no attempt was made to collects smolt samples throughout the outmigration for subsequent lab studies. Instead, all specimens retained for this purpose consisted of smolts that died during the trapping, tagging and holding periods. As a result, samples were collected unsystematically throughout the outmigration period. All smolts collected were frozen as soon as possible, and were subsequently examined at for size, weight, age, morphometric attributes, parasitic infections and scale loss. All smolts examined were weighed separately on a Mettler balance to the nearest 0.1 g. Fork lengths (FL) were measured by caliper to the nearest mm. For each smolt, five to ten scales were removed from the preferred location (Scarnecchia 1979), and placed on labelled glass slides for examination.

All ageing was done by means of a Tri-Simplex scale reader, using an 80x magnification factor. Age estimates were based mainly on the number of distinct bands of circuli observed. Initially, age estimates were compared to those obtained by other scale readers[4] so as to standardize the ageing method. It should be emphasized that the ageing method used is largely a subjective process with an undetermined error component. Bilton (1984) recognized this problem, and noted that this ageing technique had not been validated for coho salmon in B.C.

3.3 OUTMIGRATION PATTERNS AND POPULATION ATTRIBUTES

Black Creek

During the 1985 to 1987 juvenile trapping periods, water levels were adequate for conducting trapping operations, and full counts were obtained throughout each season. As a result, the daily catch records (Fig. 3.1) are representative of the actual outmigration patterns for this population.

In 1985, smolt enumeration began on May 1, but during the following years, favorable conditions for fence installation allowed the enumeration to begin earlier. This revealed that outmigration could start as early as April 8, but on average, substantial catches ($> 200 \cdot day^{-1}$) began within a 2 week period centered around May 1. Typically, daily catches would increase to at least 4000 smolts within the next 2 to 3 weeks. The peak outmigration period occurred between May 10 and May 24, with daily catches reaching up to 8800 smolts in 1986. Peak catches always occurred over a relatively short period of time (< 5 d), and were not consistently high within such periods. After this period, catches decreased progressively over the next 2 to 3 weeks. Trapping ended between May 26 and June 4, because water levels were too low (< 5 cm) to operate the

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[4] Steve Cox-Roger (International Pacific Salmon Commission), and Garry Birch (Dept. of Zoology, UBC).

smolt trap. On average, the major outmigration period lasted approximately 25 d. Field observations also indicated that the catch records are representative of the main outmigration 'pulse' each year.

Smolts were captured mostly at night until early May, and caught in equal numbers during daytime afterwards.Throughout the outmigration period, low discharge often required the installation of plastic sheets on the panels to maintain sufficient water levels for trapping operations. Visual observations suggested that daily smolt catches were influenced by the manual adjustment of water levels near the trap, as well as smolt densities and the abundance of large trout (>30 cm) in upstream pools. The combined influence of these factors undoubtedly contributed to the day to day variability in catches.

The observed seasonal smolt outputs were 50,208 (1985), 38,212 (1986), and 60,909 (1987). Fence calibration tests, conducted sporadically in 1986 and 1987, showed trapping efficiencies of 80% and 96% respectively. Usually, at least 50% of the test fish released 350 m upstream of the fence were recaptured within a 4 d period, but the remaining ones took as much as 10 d before reentering the trap. Based on a daily inspection of the fence condition, the smolt trapping efficiencies during each season were thought to be consistently greater than the tests indicated (~98%).

Each year during fence installation and dissasembly, smolts were occasionally seen moving downstream across the shallow reaches of the creek. After fence removal, several hundred smolts were observed holding in various pools further upstream, and presumably migrated to sea later on. Since some outmigration occurred prior to, and after the trapping period, the smolt catches obtained undoubtedly underestimated the actual smolt output. Based on the number of smolts observed in the stream after fence removal, it appeared that the actual output could exceed the total catch by at least 15% each year.

Tagging was conducted mostly during the early part of the outmigration period in 1985, and during the early and middle parts in 1986 and 1987. Late outmigrants were never tagged due to the excessive stress induced by high water temperatures and low flows. A highly variable portion of the smolts caught each day were tagged. During 1985, various logistic constraints and low tagging quotas allowed for only 47.6% of the total catch to be tagged. In 1986, smolt output was substantially lower, and 82.8% of the smolts caught were tagged. In 1987, only 58.5% of the increased number of smolts caught were tagged.

The average outmigration time of the smolts captured was nearly identical to that of the smolts tagged (Table 3.1). However, tagging smolts predominantly during the peak outmigration period induced differences in the outmigration period between both groups. The mean angular deviation[5] of outmigration time for the tagged group was always 1 - 2 d less than that of the captured group. As a result, statistical differences in outmigration time were detected between both groups each season (Kuiper's test, $P < 0.001$ each year). Therefore, in a strict sense, tagged groups were not entirely representative of their respective populations in terms of outmigration time.

Tag retention was consistently about 99.0%. Smolt mortality due to trapping and tagging operations each season was negligible. Total mortality due to trapping, marking and holding was estimated at less than 0.5%. Mortality due to predation was not quantified, but was noticeable. Minks, otters and kingfishers were commonly observed chasing and catching smolts in pools above the fence. In addition, minks, lampreys and large trout occasionally entered the traps at

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[5] This measure (s) is analogous to the standard deviation of linear data, and ranges from 0 to 81.03 (Zar 1984).

night, and caused considerable smolt injuries and mortalities. Approximately 10% of the untagged fish released each day showed predator injuries or deformities.

The number of smolts collected for sampling purposes during each season increased from 115 in 1985, to 257 in 1987. Preliminary examination of smolt size data revealed that some temporal variation in body length occurs during the outmigration (Fig. 3.4). During each season, smolts captured within distinct time periods exhibited significant differences in mean fork length (Kruskal-Wallis test, $P < 0.01$). Each year, the mean length was highest early in the season, near average around May 10 (calendar day 130), and smallest towards the end of the trapping season. As the season progressed, the average length of the smolts decreased by 17.5% over a 20 d period in 1985, and by 13.5% and 14.2% over a 30 d period in 1986 and 1987 respectively.

Given the temporal variation in body length, and the non-proportional sampling regime used during the study, weighted samples of length measurements were used to generate estimates of mean body size for each cohort. The estimation procedure was based on a stratified random sampling design, with each time interval considered as a distinct stratum. Using the notation from Cochran (1977), stratified estimates of the mean fork length (y_{st}) for each population were calculated as follows;

(1.1) $$\bar{y}_{st} = \sum_{h=1}^{L} W_h \bar{y}_h$$

with the associated variance estimate;

(1.2) $$V(\bar{y}_{st}) = \sum_{h=1}^{L} W_h^2 \, V(\bar{y}_h)$$

in which;

W_h = Stratum weight or fraction of total catch obtained during time interval h.
y_h = Mean length of smolts sampled during time interval h.
$V(y_{st})$ = Variance of stratified mean.
$V(y_h)$ = Variance of sample mean from time interval h.

The stratified estimates of mean fork length obtained (Table 3.4) were lower than the unstratified means obtained by averaging the mean sizes over all time periods (Fig. 3.4). The mean fork length of the 1985 cohort was found to be significantly smaller than that of the 1986 and 1987 cohorts (Tukey Test, $P < 0.001$).

Examination of the residuals from linear regressions of smolt weight against fork length indicated a curvilinear relationship between both variables. As noted by Ricker (1975), the weight-length relation is usually expressed as a power function of the type $W = a L^b$. Given weight (W) measurements in g, and fork length (FL) measurements in cm, the coefficients a and b were estimated from the simple linear regression of logarithms of weights versus lengths (Table 3.6) . Significant differences were detected among years (Analysis of covariance, $P < 0.001$). Significant difference was not detected between the slope of each regression (Tukey test, $P > 0.05$), but was detected between the elevation of each regression (1985 < 1986 and 1987, Tukey

test, $P < 0.05$). Smolts captured during 1985 weighed less for a given length than smolts captured in 1986 and 1987.

Fulton's condition factors (CF) were estimated for each smolt sampled by dividing the weight of the smolt by the cube of its fork length. Individual CF's were then used to determine the mean CF of that group. Regressions of individual CF's against their associated FL's revealed that within each group, CF's decreased with increasing FL's; small smolts were usually heavier and more variable than larger ones within the group. Estimates of CF were determined for each cohort sampled (Table 3.8). Significant differences in condition factors were detected between each year (Kruskal-Wallis, P=0.0009). The condition factor of the 1985 cohort was significantly smaller than that of the 1986 and 1987 cohorts (Dunn's Q test, $P < 0.05$). On average, the condition factor of the 1985 cohort was about 7% smaller than those of the 1986 and 1987 cohorts.

In 1985, only 30 smolts were aged from scale samples, but this number increased to 153 in 1986, and 206 in 1987 (Table 3.10). Scale examination indicated that Black Creek outmigrants consist mostly of age 1+ smolts. The contribution of age 2+ smolts to each sample was 3% in 1985, 8% in 1986, and 5% in 1987. Omitting the 1985 sample (too few cases), age 2+ smolts outmigrated, on average, approximately 3 d before age 1+ smolts, but the difference was not statistically significant (Watson U^2 test, $P > 0.05$ for both years). The mean length and weight of age 2+ smolts was consistently larger than that of age 1+ smolts, but the difference was statistically significant only for the 1986 sample (Mann-Whitney test, $P = 0.001$). The considerable overlap in length and weight of age 1+ and 2+ smolts indicates that the both groups are not distinguishable on the basis of size alone.

Trent River

During the 1985-1987 smolt enumeration periods, water levels were highly variable, and flood conditions occurred at least once every season (Fig. 3.2). As a result, light to moderate fence damage was experienced each season, and only partial counts of the total number of outmigrants were obtained.

In 1985, smolt enumeration began on May 1, but relatively high water levels prevented field crews from completing the installation of the fence before May 26. A near complete enumeration was conducted on May 5, 6, 7, 16, 19 and 20, while the fence was being modified. The negligible catches obtained on those date does not necessarily indicate low outmigration levels, since smolts can delay their migration for a day when faced with barriers, and can escape easily through incomplete fence sections. More favorable conditions during the following seasons allowed for a complete enumeration to begin by April 25. This proved sufficient for tagging purposes since substantial catches ($> 100 \cdot day^{-1}$) never occurred before May 1.

During 1986-87, substantial catches were obtained for a continuous period of 30 d, indicating a fairly extensive outmigration period for this population. Catches during the outmigration period were highly variable, and often fluctuated between high and low levels on a day to day basis. Peak catches never exceeded $1700 \cdot day^{-1}$, and always occurred between May 12 and May 25. Peak outmigration dates were not always clearly identifiable, due to the presence of several periods of high catches, and the occurrence of floods which prevented complete enumeration. Trapping was terminated between June 7 and June 15 because stream discharge was too low to operate the trap. Each year, after the fence was removed, field observations revealed the presence of hundreds of smolts remaining in pools upstream from the trapping site. The proportion of the remaining smolts that eventually migrated to sea could not be determined on the basis of subsequent visual surveys.

During the outmigration period, smolts were caught throughout the day and night, with the largest catches occurring just before dawn. Plastic sheets were required to maintain sufficient water levels only during the last 3 weeks of each season. Visual observations suggested that daily smolt catches were not affected by the manual adjustment of water levels near the traps. Perhaps the absence of holding pools in the vicinity of the fences contributed to this, since smolts committed to move downstream over shallow reaches had no place to seek refuge under conditions of relatively low water levels.

The observed seasonal smolt outputs were 12,952 (1985), 11,388 (1986), and 17,635 (1987). Fence calibration tests were only conducted in 1986 and 1987, and showed trapping efficiencies of 92-100%. Usually, at least 50% of the marked smolts released 300 m upstream from the fence were recaptured within 4 d, but some smolts took up to 16 d to re-enter the trap. Based on daily inspections of the fences, the efficiency estimates obtained from the tests were thought to be representative of the actual performance of the trap, except during periods of flooding. Given that some smolts escaped undetected during floods, as well as during the periods before and after the enumeration, the observed smolt output figures underestimate the actual output. A subjective assessment based on field observations indicated that the actual output exceeded the observed output by at least 25% in 1985 and 1986, and 20% in 1987. Field observations also suggested that the catch statistics are representative of the main outmigration 'pulses' each year, at least in terms of the temporal patterns of outmigration.

Due to logistic difficulties, tagging was conducted mostly during the middle and late part of the outmigration in 1985, and only 69% of the smolts caught were tagged. During 1986 and 1987, tagging was conducted throughout the entire enumeration period, and approximately 90% of the trapped smolts were tagged. Late migrants were always tagged since the water temperature never reached stressful levels (>16° C.), and holding densities were always low.

Tagged smolts outmigrated at a slightly earlier date than their respective populations each season (Table 3.2). The difference in outmigration time was small, ranging from 0 d in 1986, to 3 d in 1985. Differences in the variability of outmigration time of both groups, as measured by the mean angular deviation, was always less than 1 d, with the variation being always slightly larger for the enumerated group. Such minor differences were sufficient to induce statistical differences in outmigration time between both groups within each season (Kuiper's test, $P < 0.001$ each year).

The mean tag retention each season ranged from 99.0% to 99.9%. Overall smolt mortality due to trap operation, marking and holding was negligible (< 0.5%). Mortality due to predation in the vicinity of the trap was not quantified, but was less noticeable than at Black Creek. Minks and kingfishers were rarely seen, and only a few mergansers were occasionally observed feeding in tidal waters. Less than 5% of the fish released untagged each day showed distinct predator injuries. However, the majority of the smolts released untagged exhibited physical abnormalities (backbone deformity, abnormal jaws, white pupils, scale loss).

As noted in a previous section, only a portion of the outplanted fry were fin clipped prior to release in 1985 and 1986. This limited amount of information served as the basis for a crude assessment of enhancement activities in this system. Fin clipped smolts made up 34% of the total smolt catch in 1986, and 28% of the total catch in 1987, indicating a substantial contribution of hatchery releases to the total smolt output (Table 3.2). On average, approximately 92% of the fin clipped smolts captured in 1986 and 1987 consisted of fish released in Bradley Lake. For this group, the survival rate from fry to smolt, averaged over both years, was 16.5%. The survival rates of fry released in headwaters (1985), and in Bloedel Creek (1986) were much lower, with both rates between 5% and 6%. It should be emphasized that the actual survival rates of fin clipped fry are probably higher than the rates reported above, since the smolt catches obtained in this study underestimate the true smolt output each year (Section 3.5).

The contribution of the 1984 fry outplants to the 1985 smolt catches is unknown given the absence of characteristic fin clips, and the uncertainty associated with the total smolt output. Fry released in 1984 were about half the size of those released in 1985. Assuming that the 1984 releases survived at half the rate as their corresponding 1985 releases, then the 1984 fry outplants produced 5160 smolts, which represents 40% of the total smolt output of 1985. Assuming that the outplanted fry released into Bloedel Creek during 1985 survived at the same rate as those released there in 1986, then outplanted fry made up about 58% of the total smolt output in 1986. Assuming that no mortality operated between fry release and subsequent fin clipping at Bloedel Creek in 1986, then outplanted fry made up 47% of the total output in 1987. These figures suggest that the fry released by the Fish & Game club made up a major portion of the total output each year. However, it must be emphasized that these crude estimates are based upon a large number of questionable assumptions.

Significant differences between the outmigration time of clipped and unclipped smolts were detected for both seasons (Kuiper's test, $P < 0.001$). During 1986 and 1987, clipped smolts showed a tendency to leave the stream a few days later than unclipped smolts (Fig. 3.8). The difference was most pronounced in 1986, when the median date of departure of the unclipped group was 7 d earlier than that of both clipped groups. There was greater similarity between the outmigration time of L.V and R.V[6] smolts than between clipped and unclipped smolts (Kuiper's test).

The number of smolts collected for sampling purposes during each season increased from 88 in 1985, to 184 in 1987. In addition, extensive sampling of unclipped and clipped smolts was conducted in 1986 on a bi-weekly basis by R. Hurst, during which an additional 3712 smolts were measured. Samples from both surveys in 1986 were combined to produce a more accurate description of the physical attributes of the population.

Examination of the length data revealed that the size of outmigrants can vary considerably during the outmigration period in some years. Unclipped smolts captured within successive 10 d periods exhibited a small but significant difference in mean fork length during 1986 and 1987 (Kruskal-Wallis test, $P = 0.0002$, $P = 0.008$). As the season progressed, the average length of the smolts decreased by 5% over a 50 d period in 1986, and by 7% over a 30 d period in 1987. By contrast, smolts caught in 1985 exhibited a small, but non-significant increase in average body length as the season progressed.

Fin clipped smolts did not exhibit the same decrease in body length as the season progressed (Fig. 3.5). During 1986, clipped smolts captured within successive time periods showed no significant decrease in mean fork length (Kruskal-Wallis test, $P > 0.10$ for L.V and R.V groups). Smaller sample sizes obtained in 1987 showed similar patterns for L.V smolts (Kruskal-Wallis test, $P > 0.50$). Given that a portion of the unclipped smolts captured each year were probably outplanted fry, the decrease in body size of unclipped smolts observed during 1986 and 1987 may be less pronounced than that exhibited by smolts of natural origin.

Samples of length measurements for each group in a given year were weighted according to Eq. 1.1 to account for non-proportional sampling regime used. The effects of stratification upon the estimates of mean fork length were negligible. Therefore, unweighted estimates of mean fork length were used to facilitate comparisons between groups (Table 3.5). During 1986 and 1987, L.V smolts were larger than unclipped smolts, and R.V smolts captured in 1986 were the smallest. The mean size of unclipped smolts was largest in 1986, near average in 1987, and lowest in 1985.

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[6] L.V and R.V refers to marked fish lacking a left ventral or right ventral fin. Such marks were only applied to some of the fry released into the stream for enhancement or experimental purposes.

During 1985 and 1987, clipped and unclipped smolts were sampled roughly in proportion to their abundance in the catch, but R. Hurst sampled predominantly clipped smolts during 1986. In order to obtain a representative sample of length measurements for the 1986 outmigrating smolt population, random sub-samples of length measurements from each set of samples for a given group were obtained in proportion to the group's contribution to the 1986 catch. A comparison of the within season variation in smolt size exhibited by each cohort showed no consistent reduction in smolt size during each season (Fig. 3.6). Weighted estimates of mean length for each cohort were generated according to Eq. 1.1 (Table 3.4). For the 1986 cohort, weighted estimates of mean length were nearly identical to unweighted estimates. The average smolt size was highest in 1986, lowest in 1985, and near average in 1987. The maximum year to year change was observed between 1985 and 1986, during which the average length increase by 16%.

Only a fraction of the fish measured in 1986 by R. Hurst were weighed. These weight measurements were combined with those collected during this study to estimate the weight to length relationships for the unclipped, L.V and R.V groups (Table 3.7). Significant differences were detected among the groups in 1986 (Analysis of covariance, $P < 0.001$). Significant differences were not detected between the slope of each regression (Tukey test, $P > 0.05$), but were detected between the elevation of the regression for the unclipped group, and those of the L.V and R.V groups (Tukey Test, $P < 0.05$). This indicates that clipped and unclipped smolts of a given length differed in weight. Condition factors were determined for each group (Table 3.9). Significant differences in condition factors were detected between the groups (Kruskal-Wallis test, $P < 0.001$). The condition factor of the unclipped group was significantly larger than that of both clipped groups (Dunn's Q test, $P < 0.05$). On average, the condition factor of the unclipped group was about 6% larger than that of the clipped groups.

Weight to length relationships were also determined for L.V and unclipped smolts captured in 1987 (Table 3.7). Significant differences in elevation and slope were detected between both regressions (t-test for slopes and elevations, $P < 0.05$). The average condition factor of L.V smolts was significantly lower than that of the unmarked smolts (Mann-Whitney test, $P < 0.001$), with the difference being about 6.5% (Table 3.9).

In order to best describe the outmigrating smolt population each year, random sub-samples of length and weight measurements were obtained from each set of measurements, for a given group, in proportion to the group's contribution to the total catch that year. The resulting sample of measurements was used to determine the weight to length relationship for each cohort (Table 3.6). Significant differences were detected among the groups (Analysis of covariance, $P < 0.001$). Significant differences were not detected between the slope of each regression (Tukey test, $P > 0.05$), but were detected between the elevation of each regression (Tukey Test, $P < 0.05$), which indicates that smolts of a given length exhibit year to year differences in weight. Condition factors were determined for each cohort (Table 3.8). Significant differences in condition factors were detected among cohorts (Kruskal-Wallis, $P=0.0001$). The condition factor of each cohort were significantly different to one another (Dunn's Q test, $P < 0.05$). The 1987 cohort had the largest CF, which was about 6% greater than that of the 1985 cohort, which had the lowest CF.

In 1985, only 22 smolts were aged from scale samples, but this number increased to 122 in 1986, and 183 in 1987. Only a single smolt captured in 1986 was determined to be of age 2+, while all others examined were of age 1+. This smolt measured 102.6 mm and weighed 11.8 g, which is very similar to the average smolt size observed during 1986. These results suggest that age 2+ are rare in this river, and probably account for less than 1% of the outmigrating population each year. The similarity in size between both age groups indicates that age 2+ smolts cannot be distinguished from age 1+ smolts on the basis of size alone.

French Creek

Smolt enumeration was not conducted during 1985 at French Creek because of concerns raised by DFO staff about the proposed trapping program. However, trapping and tagging operations were conducted as planned in 1986 and 1987. During both seasons, water levels were adequate for enumeration purposes, and full counts were obtained each day. As a result, the catch patterns presented (Fig. 3.3) are representative of the actual outmigration patterns for this population.

During 1986 and 1987, smolt enumeration began around mid-April. By then, the outmigration was already in progress, as indicated by the small catch rates obtained. Smolt catches increased progressively thereafter, and reached 100·day^{-1} during the week centered around May 1 when the water temperature reached 10° C. Peak catches of ≈ 2000·day^{-1} occurred only twice each season within the May 15-27 period, but catches exceeding 1000·day^{-1} were obtained frequently within the 3 week period centered around the peak period. During the 2 weeks following this peak, catches usually decreased progressively as did the water levels. Each season, trapping was terminated between June 6-12 because stream discharge was too low to operate the trap. The duration of the main outmigration period was about the same each year, or approximately 40 d. The median date of outmigration during 1987 was 8 d earlier than in 1986 (Table 3.3).

Throughout the outmigration period each year, smolts were captured almost exclusively at night and at dawn. Daytime catches were obtained only occasionally during the last part of each season, when water temperatures were ≥ 13° C. Plastic sheets were rarely used in 1986 to maintain water levels in the vicinity of the trap, but were required throughout 1987 because of unseasonably low water levels. Visual observations indicated that manual adjustments of water levels near the trap did not appear to influence the migration pattern of the smolts. Smolts seemed to be more responsive to natural increases in stream flow, the smolt densities in upstream pools, and the presence of predators near the trapping area.

Over the 2 year period, smolt output increased slightly from 29,155 to 33,917 (Table 3.3). A single fence calibration test was conducted during each season, with both tests indicating a trapping efficiency of 100%. During 1986, it took 18 d to recapture all 25 marked smolts released upstream, compared to 9 d in 1987. During both tests, 50% of the marked fish were recaptured within 3 d after release. Based on a daily inspection of the fence, the efficiency estimates obtained from the tests were thought to be representative of the actual performance of the trap. However, each year, smolts undoubtedly escaped undetected prior to completing the fence installation, as well as after the removal of the fence. A subjective assessment based on visual surveys indicated that the actual output exceeded the observed output by at least 10% in both years.

During both seasons, tagging was conducted throughout the outmigration period, and was centered around the peak outmigration period. Smolts caught during the first week were not tagged due to logistic constraints, while those caught at the end of the season were released untagged due to insufficient flows through the holding boxes. Approximately 24,000 smolts were tagged each season, representing about 82% of the 1986 catch, and 72% of the 1987 catch. The median date of outmigration of the enumerated and tagged groups were identical each year. Given that smolts captured at the tail ends of the outmigration period were not tagged, the outmigration period of the tagged group was always shorter than that of the enumerated group. This was sufficient to induce significant differences in outmigration time between both groups within each season (Kuiper's test, $P<0.001$), meaning that in a strict sense, marked groups are not entirely representative of their respective populations.

Seasonal averages in tag retention rates exceeded 99% each year. Overall smolt mortality due to trap operation, marking and holding appeared to be negligible (<0.5%). Mortality due to

predation in the vicinity of the trap was not quantified, but did not appear to be a serious problem. Muskrats, kingfishers and mergansers were occasionally seen catching fish in the various pools 100 to 200 m downstream from the traps, but rarely in the vicinity of the fence. Less than 5% of the fish released untagged each day showed distinct predator injuries, but nearly all of them exhibited physical abnormalities (backbone deformity, white pupils, extended eyeballs, scale loss, jaw injury, etc.).

A noted in a previous section, a small portion of the fry released by the Fish & Game club each year were fin clipped. Information on the catches of fin clipped smolts was used for a preliminary assessment of the success of enhancement activities in this stream. Fin clipped smolts made up 2.6% of the total smolt catch in 1986, and 3.1% of the 1987 catch. The fry to smolt survival rates for releases into Dudley marsh were highly variable from one year to the next, with 1 g fry released in 1986 surviving at the same rate as 5 g fry released in 1985. The relatively low survival rate of the 5 g fry was attributed to the freeze-up that occurred during the winter following the transplant (R. Hurst, pers. comm.). Large fry (6 g) released during Oct. 1986 in Dudley marsh showed the highest survival (>17%), which may be more representative of the average survival rate that can be obtained from such releases.

The conditions in Dudley marsh differ substantially from those in the main section of the stream, and the survival rates of fry released in each area are probably not comparable. Given the absence of a characteristic fin clip, and the lack of comparable releases of marked fry in the past, it is impossible to estimate the survival rates of the fry released into the mainstem, or their contribution to the total smolt output. In view of the year to year variability in survival rate of Dudley marsh releases, no attempt was made at estimating the survival rates and contribution of the mainstem releases.

During both seasons, smolts that had reared in Dudley marsh outmigrated much earlier than those from the stream itself (Fig. 3.9). The median date of outmigration of both groups was markedly different, with the Dudley marsh releases leaving 10 d earlier in 1986, and 15-16 d earlier in 1987. Each year, by the time the outmigration of the unmarked group was half complete, over 90% of the smolts from Dudley marsh had outmigrated. Within the Dudley marsh group, fish released as large fry (6 g) late in the season began their outmigration earlier than those released as 1 g fry in May. Many smolts from the first group were captured as soon as the trap was operational, which raises the possibility that a significant portion of this group may have outmigrated before the fence installation was complete.

The number of smolts collected for sampling purposes increased from 163 in 1986, to 250 in 1987. Examination of length data revealed that the average size of smolts captured changed during the outmigration each year (Fig. 3.7). Unmarked smolts captured within successive 10 d periods exhibited significant differences in average fork length during both years (Kruskal-Wallis test, $P < 0.001$ for 1986 and 1987). As the season progressed, the average length decreased by 5% over 30 d in 1986, and by 17% over 40 d in 1987. It is not known if marked smolts exhibited similar trends, as the samples were too irregularly spaced, and were not sufficiently large for comparative purposes.

Samples of length measurements taken each year were weighted according to Eq. 1.1 to compensate for the non-proportional sampling regime used (Table 3.4). The mean fork length of the 1987 cohort was only 2.5% greater than that of the 1986 cohort, but the difference was significant (t-test, $P< 0.05$). Clipped and unclipped smolts could not be statistically compared for size differences since clipped smolts were not sampled in 1986, and only a single clipped smolt was measured in 1987.

Weight to length relationships were determined for the 1986 and 1987 cohorts (Table 3.8), but could not be determined specifically for clipped groups because of insufficient samples.

Significant differences were detected between the slopes and elevations of the regressions describing each cohort (t-test, $P < 0.05$), indicating year to year changes in smolt condition. Standard CF's were determined for each cohort (Tables 3.9). Significant differences in CF's were detected between each cohort (Mann-Whitney test, $P < 0.01$), as the average CF decreased by about 3% between 1986 and 1987.

All smolts sampled in 1986 were aged, as well as 237 smolts collected in 1987. The vast majority of the smolts examined were age 1+. The proportion of age 2+ smolts in each sample was 0.6% and 2.5% respectively. Age 2+ smolts were usually larger and heavier than age 1+ smolts, but could not be identified on the basis of size alone, because both age groups overlapped considerably in length and weight (Table 3.11, 1987 season).

3.4 STOCK AND ANNUAL VARIATION IN OUTMIGRATION PATTERN

The results obtained at Black Creek were very similar to those obtained previously during other trapping operations at this location as reported by Clark and Irvine (1989) and Fielden *et al.* (1989). The 1978, 1979 and 1988 outmigrations occurred predominantly during the late April to early June period, and peaked within the May 10 to May 24 period. Mean smolt sizes and weights during 1978, 1979, and 1988 were estimated at 115, 111 and 113 mm, and 15.6, 14.8 and 14.5 g respectively. During 1978 and 1979, age 1+ smolts comprised >96% of the smolts aged each year, had an average fork length of 100 to 115 mm, and an average weight of 15.6 to 14.5 g. Age 2+ smolts had an average length of 123 to 142 mm, and a weight of 17 to 28 g. Early migrants were significantly larger and heavier than late migrants in 1978 and 1988, but not in 1979. Smolts lacking an adipose fin at capture accounted for 0.02 to 0.03% of the smolts examined in 1978 and 1979. Such results indicate that the timing of the outmigration, as well as the condition and composition of the outmigrating population are fairly consistent from year to year in this stream. However, the average length and weight of the 1985 outmigrants still remains well below the overall seasonal average, and both size measurements are lower than the corresponding means for other seasons.

Fielden *et al.* (1989) determined that the 1988 Trent River outmigrants averaged 103.9 mm in fork length, and 11.76 g in weight. Both estimates are slightly larger than the largest average size observed during this study, with the average size and weight of the 1985 outmigrants remaining well below the overall seasonal average. The average fork length of the outmigrants each year was correlated with the average weight of the fry outplanted in the previous year (Spearman's rank correlation, $r_S = 1.0$), indicating that the condition of the fry released in the Trent River may have an important effect upon the condition of the outmigrants. As was observed during this study, the peak outmigration period during the 1988 season occurred between the second and third week of May.

Fielden *et al.* (1989) determined that the 1988 French Creek outmigrants averaged 101.1 mm in fork length, and 10.2 g in weight. Significant differences in fork length were detected between each cohort (ANOVA, $P < 0.01$), with the 1988 outmigrants being significantly larger than the 1986 and 1987 outmigrants (Tukey test, $P < 0.05$). No correlation was found between the average length of the outmigrants, and the size of the fry released in the stream during the preceding year. However, it should be noted that the time of release varies considerably from year to year, which makes it difficult to determine the exact effects of size at release upon the condition of the smolts produced. Peak outmigration in 1988 occurred during the third week of May, which is in the middle of the peak period for 1986 and 1987.

During the 1985 to 1988 period, Black Creek smolts were, on average, 14% larger in length than Trent River smolts, and 21% larger than French Creek smolts. The magnitude of the year to year differences in size and weight between each population is affected by genetic factors, the physical conditions in each stream during the rearing period, the number and condition of the fry outplanted, and the resulting fry densities. No attempt was made at quantifying the effects of each of these factors upon the differences in size, weight and condition factors in this report.

A rigorous statistical assessment of the variability in outmigration patterns observed between years among the populations surveyed is not possible since only partial counts were obtained during this study. However, the main outmigration pulse of each population was clearly identified each year, and provides some information on stock-specific trends in outmigration patterns. The median dates of outmigration associated with the main outmigration pulse of each population for the 1985-1988 period were determined based on observations conducted during the present study (Tables 3.1 - 3.3), and by Fielden *et al.* (1989). The median outmigration date for Trent River smolts in 1985 was set at May 22, instead of May 29, to account for the undetected outmigration that presumably occurred while the fence was being installed (Section 3.5). The resulting estimates indicated that the median date of outmigration of Black Creek smolts occurred, on average, 7 d before that of Trent River smolts, and 4 d before that of French Creek smolts. The median dates for all three populations exhibited similar trends during the 1985 to 1988 period, by being near average in 1985 and 1988, above average in 1986, and below average in 1987. Median dates were ranked and submitted to an unbalanced two-way ANOVA with no replication (one estimate per year, with no estimate for French Creek in 1985). Both factors, namely population and season, were found to have significant effects upon the median date of outmigration (P=.021 and P=.035). Such results suggest that the 3 populations respond similarly to some environmental factors which varies between seasons. Average water temperature and day length are both factors known to affect smoltification, and are hypothesized to have a significant effect upon all populations within the geographical area of interest. However, additional surveys need to be conducted in the future to substantiate these findings.

3.5 TOTAL SMOLT OUTPUT AND STREAM CARRYING CAPACITY

Since a complete enumeration of all outmigrants was never achieved during this study, the actual smolt output in each system must be estimated to assess the productivity of each stream. In trapping programs such as this one, total smolt output is often determined on the basis of trap efficiency tests. However, it should be emphasized that such tests only provide at best, crude estimates of the minimum proportion of all smolts present that move downstream during the test period. Marked smolts released upstream may be subject to predation, may be reluctant to re-enter the trap, or may exhibit abnormal behavior due to stress and delay their outmigration. During past studies in the Quinsam River (Quinsam Coal Project), marked fish released for calibration purposes were captured at the same site a year later (B. Lister, pers. comm.). Similar results have been obtained with coho smolts released above the fence on the Keogh River, and at Black Creek in 1989 (Dr. Jim Irvine, pers. comm.). In view of such facts, total smolt output was not estimated on the basis of traditional trap efficiency tests.

As an alternative, total smolt output in each stream was determined by reference to the tagged proportions at release and at return. For this estimation procedure to be valid, the tagged proportions among adults escaping to each stream must reflect the tagged proportions among the juveniles at release for that cohort. This is only achieved if the following assumptions are met;

1. Outmigrating fry that are displaced by residents do not survive until maturity and escape to the stream. This means that all adults in the escapement must have outmigrated from the stream during the same season;

2. Tagged and untagged smolts are subject to the same rates of natural mortality, maturation rates and migratory behavior;

3. There is no immigration of spawners from other streams in the escapement (straying). Thus, the tagged ratios in the escapement reflect the true tag ratio for that stock;

Failure to meet any of these assumptions would cause the total smolt output to be overestimated. No evidence was obtained during this study to reject assumption #1 (Section 6.1). In addition, no evidence was obtained from the literature, or during this study to indicate that tagging induced substantial differential mortality or subsequent behavioral changes. With regards to assumption #3, large numbers of strays were detected only in the Trent River, but efforts were made to account for their presence in order to obtain the tagged ratios among adults of Trent River origin (Section 6.1). Still, it is possible that these assumptions were violated to a certain extent during this study, so the estimates generated should be considered as maximum smolt outputs.

A comparison of the tagged proportions among juveniles and adults revealed that the former was always greater than the latter (Table 3.12). The magnitude of the difference was generally greater than was expected on the basis of the subjective assessments of the number of undetected outmigrants. Major discrepancies are apparent for the 1985 outmigration at Trent River and Black Creek, which suggests that only 15% and 35% of the respective smolt outputs were enumerated at each location. The 1985 trapping operations at both locations were conducted under conditions similar to those of 1986 and 1987, during which an apparently larger and more constant proportion of the total smolt output was enumerated. In view of the magnitude of such discrepancies, it is reasonable to suspect some serious violation of the above assumptions.

The only major difference in operation concerned the use of MS222 as the main anaesthetic at both locations in 1985 (instead of 2-Phenoxyethanol), which may have contributed to greater differential mortality. However, juvenile trapping and tagging at Black Creek during 1985 were conducted under the same conditions, by the same tagger (Dan Clark), with the same anaesthetic (MS222), as in 1978 and 1979, without similar consequences. During 1985, tagging effort at Black Creek was directed predominantly on the early (and larger) outmigrants which show a tendency to return as jacks. Assuming that the tagged proportion among the returning jacks is more representative than the proportions among adults still translates into a total output of about 100,000 smolts. The possibility remains that there is substantial year to year variation in the number and survival rate of displaced fry, which can potentially make significant contribution to the total escapement, and reduce the tagged proportions at return. In the absence of any further evidence to invalidate the assumptions, it must be assumed that smolt output in 1985 was substantially higher than in other years, and may have exceeded 100,000 smolts. Such high smolt output may have been the cause for the significantly lower mean size and condition factors of the 1985 outmigrants, brought about by limited resources and high levels of competitions in freshwater.

With regards to the Trent River, the situation is more complex, mainly due to the estimation of the number of strays in the escapement (Section 6.1). It is possible that the number of adult strays escaping to the Trent River in 1986 was underestimated, as it is impossible to assess the contribution of strays from natural, untagged stocks. The presence of the strays would cause the tagged proportion among Trent River adults to be negatively biased. Alternatively, the effects of MS222 might have been more pronounced at Trent River than at Black Creek, since tagged smolts were exposed to tidal waters immediately after release. Still the possibility remains that the estimated figure corresponds to the actual smolt output for that year. The unusually high smolt

output could have been induced by a combination of natural production, and high survival associated with the massive number of fry released in the headwaters (180,000 in 1984). It should be noted that magnitude of the 1984 fry outplants was about twice as large as the 1986 outplants (1985 outplants and 1986 smolt output omitted due to freeze-up). Concurrently, the resulting smolt output for 1985 was estimated to be 2.4 times that of 1987. The large fry population resulting from the 1984 outplants may have been responsible for the significantly lower mean size and condition factor of the 1985 outmigrants. A major portion of the resulting smolt population could have outmigrated during the period of high water preceding the trapping operations, as well as after the trapping period. In view of such facts, this relatively high smolt output estimate for 1985 cannot be rejected based on the evidence available.

Discrepancies between tagged proportions associated with the 1986 and 1987 releases are considered to be realistic. The discrepancies are highest for the Trent River, were minor floods occurred each season, and smallest at Black Creek, where juvenile trapping was easiest to conduct. The proportion of the total output enumerated each season at French Creek was surprisingly variable given the extent of the trapping season, but not unrealistic if one assumes that some outmigration may occur sporadically before and after trapping operations.

Assuming that the estimates of total smolt output are correct, it appears that the smolt output in these streams can be quite variable from one year to the next, even in the absence of enhancement. In the absence of accurate escapement records prior to 1984, and information on the exact contribution of the enhancement programs, smolt output per spawner cannot be determined with certainty for French Creek and Trent River. For Black Creek, the estimates based on the 1984-1987 spawner abundance figures (Table 5.7), and the associated 1986-1988 smolt output figures indicate that smolt production per female ranged from 15.6 (1986 output) to 32.0 (1988). However, using unpublished estimates of smolt output for 1989 (R. Bocking[7], pers. comm.), an estimate of 76.5 smolts per female was obtained. This figure is substantially greater than the those obtained during the present study, and may indicate a potential output level that can be achieved under conditions of low fry densities, brought about by the lowest escapement levels observed since 1984 (Section 6.1). It should be noted that none of the above estimates were associated with relatively high escapement levels as reported for years previous to this study.

Estimates of total smolt output and stream size were used to provide preliminary estimates of the potential carrying capacity per kilometer in each stream. For Black Creek, maximum smolt output per km per year ranged from 5431 in 1985, to 1730 in 1986, and averaged 2849 across all years. At Trent River, the mean was 1400, with a range of 2822 to 766, and for French Creek, the mean was 2141, with a range of 2926 to 1378.

These figures should be interpreted with caution, since the area of habitat available is not known with certainty. Although systematic surveys were not conducted for this purpose, field observations revealed substantial changes in the availability of rearing habitats in all streams during this study. During the very cold period in the fall of 1985, entire stream sections normally used as spawning grounds were frozen. Some rearing habitats such as small pools and shallow reaches normally used for overwintering purposes were observed to be totally frozen. Large numbers of dead fry were reported to have been found in pools at French Creek after the ice had thawed (R. Hurst, pers. comm.). This weather anomaly was also accompanied by unusually dry summers in 1985 and 1986 when entire sections of stream dried up totally.

Marshall and Britton (1980) reported an average carrying capacity of 1782-1894 smolts per km for streams 20-30 km in length, from Washington and southern B.C. The mean smolt output estimated for Black Creek and French Creek was above the average reported for streams of similar

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[7] LGL Ltd., 9768 Second st., Sidney, B.C.

sizes. It remains to be determined if such high smolt output reflects the quality of the habitat, particular attributes of the resident stock, or a combination of both factors. By contrast, the smolt output per km observed at Trent River is below the estimate reported by Marshall and Britton (1980) for streams of similar length. The scarcity of good rearing and overwintering habitat in the main section undoubtedly has some major influence, and may always hamper attempts to enhance the coho population by fry outplants (as oppose to habitat alterations).

4.0 ESCAPEMENT ENUMERATION

4.1 INTRODUCTION

In order to collect coded-wire tag returns, and obtain accurate estimates of total return to each stream, counting fences were required at each location. Most conventional fence designs have 2 shortcomings, their cost and their susceptibility to damage from debris build-up and flooding. The common occurrence of floods in these streams, coupled with bank erosion and scouring from logs and forest debris, precluded the use of inexpensive conventional fences. In order to overcome such problems, escapement enumeration was conducted by means of semi-permanent collapsible fences. Mark-recapture operations were conducted in conjunction with fence operations to estimate escapement levels in each stream. Surveys were also done periodically in each stream throughout the spawning periods to determine the marked proportions, recover coded-wire tags, and obtain additional information on the demographic traits of each population.

4.2 MATERIALS AND METHODS

Fence design

The fences used were designed by SEP engineer R. Finnigan of DFO's Special Projects Division. Prototypes of the fence had previously been installed and tested at Kanaka Creek, Lang Creek and Sliammon River, and had proven to be relatively inexpensive and reliable. The main feature of this fence is that it can be collapsed onto the streambed during periods of floods. Specifications for construction and installation of this fence were obtained from SEP (blueprint #33-26-8 and #33-26-9). A brief summary of the main characteristics of the fence and its performance is given below.

The fence consist of a series of interconnected wooden frame panels with aluminum tube insets. The base of the panels are hinged on a foundation composed of wooden sills imbedded across the river. The top end of each panel is attached to a supporting beam which spans the whole width of the stream. Thus, all panels can be lowered or raised simultaneously against the current up to a 50° angle. The supporting beam can be articulated into position through the use of pulleys, winches and cables stretched across the stream. Wooden abutments installed on each stream bank hold the winches as well as the wooden towers used to support the main cable and pulleys.

Small debris passes through the fence, but large leaves and branches are retained. These must be periodically brushed off the panels by field crews, who use the fence as a walkway during

cleaning periods. Since the fence is wedged against the current in an inclined position and does not project greatly above the water, large floating debris are easily raked over the fence. Occasionally, the cables attached to the downstream edge of the fence can get caught by logs and branches. When substantial pressure is applied, these cables slide off the hooks connecting them to the beam, causing a partial collapse of the fence, and allowing the debris to float downstream. Cables can be hooked subsequently under appropriate hydrological conditions, and the panels raised again.

Most of the large logs and branches move downstream during floods. At times when floods and excessive debris build-up are anticipated, the fence can be lowered partly so that ample headroom is left for the debris to pass over the fence. This allows some fish to move upstream, but it greatly reduces the possibility of damage. Unfortunately, the fence is particularly susceptible to damage by logs and stumps which scour the streambed and catch the base of the panels. When this type of damage occurs, field crews must wait for water levels to recede before repairing the fence. Because of the modular design of the structure, fence components separate from each other during breakdowns, and get dispersed on the streambed further downstream. The fence can eventually be reassembled within a few hours under appropriate hydrological conditions.

During normal fence operations, all upstream migrants are funnelled into a large (1.5 m x 3 m) trap made of wooden dowlings. This trap is located adjacent to the abutment, on the upstream side of the fence. Salmon moving upstream generally home in on the turbulence created below the trap entrance on the downstream side of the fence. From there, they enter a wooden tunnel that extends through the sill, and leads into the trap. The configuration of this channel forces fish to swim under the fence panels. As a result, fish can access the trap even during periods of low water levels.

Fence locations

Preliminary field surveys identified potential sites for fence locations, based on considerations of flow rates, stream widths, geomorphological characteristics and accessibility. Final decision regarding fence location was made in conjunction with local authorities, DFO fishery officers and SEP engineers.

At Black Creek, the site chosen was approximately 0.5 km from the mouth of the river, inside the Miracle Beach Park, adjacent to the road leading from Highway 19 to the Miracle Beach resort. This location is approximately 10 m downstream from the juvenile trapping site, and is beyond tidal influence. At this location, stream width is approximately 16 m, with the streambed composed of a stable mixture of small rocks, cobble and gravel. One of the main reasons for selecting this site was the existence of a well preserved concrete structure used for the old escapement fence which was operated in 1979-1980. The availability of the abutments and sill meant substantial financial savings to the total cost of the new fence.

On the Trent River, the site chosen lies some 300 m downstream from the Highway 19 bridge over the river, or approximately 600 m downstream from the juvenile trapping site. At this location, stream width is approximately 24 m, and the streambed is characterized by an unstable and uneven mixture of rocks, gravel and sand. This area is strongly influenced by the tides, which alone can account for daily variations of 1.5 m in water levels. This location was determined by fishery officers mainly for reasons of convenience. Ideally, an area further upstream beyond tidal influence, would have been more suitable for operating this type of fence.

At French Creek, the site chosen lies behind the French Creek hatchery on Miller Road, approximately 1.5 km upstream of the estuary. At this location, the stream is about 20 m wide, and the streambed composed of gravel, cobble and small rocks. This site lies beyond tidal reaches, and is approximately 100 m above the smolt trapping site.

Fence installation

All fence components were prefabricated in Courtenay prior to the installation. Most of the specifications outlined in the SEP blueprints were followed during the construction of each fence. Only slight modifications were made to adapt each structure to local conditions.

At Black Creek, modifications were made to the old structure in order to accommodate the collapsible fence design. The old structure consisted of two concrete abutments, some 16 m apart on each bank, connected by a 1 m wide concrete sill. The existing abutments were extend from 2.5 m to 4 m, and encased in a wooden structure to provide sufficient area for the winches and towers. A rectangular tunnel (15 cm x 1 m x 2 m) was installed on top of the cement sill to serve as a trap entrance. The aluminum panels normally hinged on the sill were positioned on top of this tunnel. During the 1985 season, this trap entrance worked well only when there was a moderately strong flow. During 1986, a small channel (15 cm x 30 cm) was cut into the concrete sill to allow greater flow in the trap entrance. This improved the effectiveness of the trap entrance during the 1986-1988 seasons.

At Black Creek, a 4 m x 1 m trap was used to provide sufficient space to handle the large catches and facilitate processing. At Trent River and French Creek, the front portion of the traps were strengthened by using iron bars instead of wooden dowling, to make the traps more resistant to damage from floating logs. Additional braces were used on the towers of the Trent River fence to support the heavy load of a longer fence. Finally, at all locations, the main cables were secured to large trees, as opposed to buried logs, to reduce costs and provide stronger anchoring.

On average, the installation of each fence required approximately 3 days of tractor work, and 45 man days of labour. The most labour intensive tasks were the positioning of the abutments and sill in the streambed, and the installation of the gabions to stabilize the banks. An additional 30 man days was required to complete the installation and the necessary rock work.

Fence operation and enumeration procedure

Each fence was assembled prior to the first fall rains, while the stream flows were negligible. Once the installation was complete, each fence was checked periodically until the up-stream migration began. Throughout the run, each fence was monitored every day by at least one worker during all daylight hours. The usual schedule of activities was as follows;.

Field crews usually arrived at daylight. All debris which had accumulated overnight on the fence panels was brushed off and released downstream. Fence components, towers and the trap were inspected for damage, and if necessary, repairs were done immediately and recorded. Fence inclination was then adjusted on the basis of prevailing water levels to maximize trapping efficiency. If water conditions were too low to provide a good flow through the trap entrance, plastic sheets were placed over some panels to concentrate the flow though the trap.

Fish captured overnight were dipnetted out of the trap, processed, marked and released upstream. While sorting the catch, each fish was identified, and examined for injuries and missing fins. The total number of adults and jacks was recorded, as well as the number of fish in each category that lacked a particular fin. All fish lacking an adipose fin were assumed to be coded-wire tagged and recorded as such. Tagged fish were usually not killed at the fence, in order to allow most fish to spawn. Tagged coho recovered as carcasses below the fence, or seriously injured at capture, were measured, sexed and beheaded for CWT recovery. Each head recovered was placed

in a plastic bag, labelled and stored in a freezer, until shipment to DFO's Head Recovery Laboratory for identification.

The same procedure was repeated through the day when necessary. In addition, the area downstream from the fence was surveyed intermittently to determine the number of fish holding, and to recover carcasses. At the end of the day, the angle of the fence was adjusted in relation to the anticipated flow rates. During 1985, adult enumeration was not conducted at night given the limited manpower and equipment available, and lack of adequate means of communication. During all subsequent seasons, adult enumeration was conducted throughout the night during the peak upmigration periods, as additional resources were available.

At the request of the local Fish & Game clubs, some adult coho were retained at the French Creek and Trent River fences to supply the local hatcheries with brood stock. Efforts were made to retain at least 10% of the fence catch for this purpose. No attempt was made to select adults on the basis of their sex or size. Instead, adults were selected exclusively on the basis of their general condition. Efforts were made to select primarily adult coho in an intermediate or advanced stage of maturation, since silver, immature fish were less tolerant to handling and transportation. Efforts were also made to collect the fish required throughout the period of upmigration, rather than on a single occasion. This last objective was also necessary to meet the assumptions of the mark-recapture program (Section 5.2).

During 1985, a complete enumeration of the adult escapement at Black Creek and French Creek was not permitted. During the first week of upmigration, the fence traps at these locations remained open at night, at the request of local DFO authorities, who were concerned about excessive build-ups of fish below the fence. Complete enumeration was allowed in subsequent years.

Marking procedures

The precision and accuracy of mark-recapture estimates is, to a large extent, determined by the marking and recovery efforts used. Preliminary field surveys in 1984 indicated that a considerable amount of effort would be required to capture more than 100-200 coho near the spawning grounds given the adult densities observed. Therefore, it was judged necessary to increase the marking effort relative to the recovery effort to compensate for the anticipated low recovery rates. The marking and sampling targets were set at 40% and 10% of the escapement respectively. According to Robson and Regier (1964), this effort allocation allows Petersen estimates to be within 10% of the true value, 19 times out of 20. These authors also noted that under such conditions, the resulting bias associated with N can be considered negligible (< 2%).

As a result of concerns expressed by local DFO officials over the potential effects of the marking plans, some restrictions were imposed in 1985. The use of external, numbered tags was not allowed for general marking purposes. In addition, marking could only be conducted when there was no apparent build-up of fish below the fence. When build-ups occurred, marking had to be temporarily stopped until the build-up had been eliminated. Because of these restrictions, a substantial portion of the fish intercepted at the fences in 1985 and 1986 had to be released without marks. These restrictions were relaxed during 1987 and 1988 to facilitate the study.

All remaining coho were marked by means of a hand held paper punch. During 1985 and 1986, an 8 mm wide hole placed in either the upper, middle or lower lobe of the caudal fin, depending on their time of passage at the fence. This procedure was used in the hope of determining the migration rate, distribution and stream residency of different components of the run. Following a suggestion by Dr. J. R. Irvine, tail marks were replaced by opercular marks in 1987, which proved to be less susceptible to fraying, and more readily discernible on carcasses.

Irrespective of the body area used, once released, marked fish did not appear to be noticeably different than unmarked ones, and both groups were considered to be equally detectable.

Attempts were made to mark coho throughout the run. Fish exhibiting serious injuries were usually released upstream without marks. In addition, some coho were retained for brood stock acquisition purposes. As a result, marks were not applied to a fixed portion of the daily catch, nor were they applied proportionally throughout the run.

Individually numbered external tags were also applied on a limited number of coho during 1987 and 1988 to estimate the period of stream residency (Bocking *et al.* 1988). During 1987, Petersen disks were used to tag coho at all locations. At Black Creek, tags were applied to 68 adult coho on November 17. At Trent River, 43 adult coho were captured and tagged in the headwaters on November 9, and 12 more were captured and tagged 1 km above the fence site. No tags were applied at French Creek due to the low numbers of adults caught (Bocking *et al.* 1988). During 1988, colored spaghetti tags were used at all locations. At Black Creek, 100 adults were tagged on November 1, and again on November 4. At Trent River, 30 adults and 20 jacks were tagged on October 25. At French Creek, 50 adults were tagged on November 1, and 20 adults on November 3 (R .Bocking, pers. comm).

4.3 FENCE PERFORMANCES

The frequent occurrence of floods at Trent river, and the unanticipated debris build-up at night caused considerable damage to this fence on many occasions. Large tree stumps, scouring the streambed while being displaced downstream, hooked the base of the panels at least once a year, causing the fence to break apart. The supporting beam was broken many times, and had to be braced or rebuilt entirely. The main cable tore apart during 1987, and had to be replaced. However, the traps, towers and panels were never damaged, and the fence could usually be reassembled within 48 h after flood waters had receded. The fences were not as self-cleaning as expected. Large leaves accumulated on the flat-bar welded across the panels, and were difficult to remove even with brushes and rakes. Eliminating the flat bar across each panel should allow more debris to pass through the fence, without substantially reducing the strength of the panels.

When water levels were < 0.5 m, all fences seemed to intercept over 95% of all adults. Small adults (< 35 cm), and a highly variable portion of the jacks present could swim between the aluminum bars of the panels, as well as between the dowling of the trap. All attempts to modify the panels and traps so as to prevent the passage of small coho, caused additional debris build-up, and lead to increased stress loads on the supporting cables.

The traps were adequate in strength, provided sufficient space for handling the catch, and did not induce injuries to the fish. However, the existing trap entrance at Black Creek should be altered to improve the trapping efficiency. Widening the entrance to 1.5 m would definitely funnel more fish directly into the trap entrance. The trap itself should be widened and extended further upstream.

Field observations in 1985 indicated that the shape of the streambed below the fence seemed to influence trapping efficiency during the early part of the adult migration. Under conditions of low water levels, fish moving upstream often found refuge in the surrounding pools after a brief attempt to pass through the fence. When small pools in the vicinity of the French Creek fence were filled with boulders, coho appeared to search longer for an opening, and were caught more readily. During 1986, a 100 m section of streambed below the French Creek fence was leveled with a backhoe, and then slightly channelled towards the fence entrance. As expected,

during the initial period of upmigration, coho were observed to swim directly into the trap while water levels were still low. Trapping efficiency at Black Creek and Trent River could be improved in this manner by levelling the 80 m section below the fence.

4.4 RUN PATTERNS AND COMPOSITIONS

Black Creek

Each year, coho began aggregating at the stream mouth during late September. Prior to the first freshet, water levels were usually too low for coho to access the lower pools. A substantial amount of precipitation was required each fall to fill Northy Lake, and provide sufficient outflow to raise the water levels in the lower reaches. Coho arrived at the fence as soon as the water levels across the cement sill reached 10 cm. During 1985, the upmigration began relatively early in the year, and most coho examined were silver and had some ectoparasites (sea lice). Some adults caught in late November also had this appearance, suggesting that coho were still entering the stream by this date.

From 1986 to 1988, delays in the arrival of fall rains forced all early migrants to hold near the estuary. Each year during this period, between 5 and 50 were recovered in intertidal waters. Minor catches reported during 1986 prior to the first major migration pulse correspond to the recoveries of dead coho along the bank (Fig. 4.1). During 1986 and 1987, when the first freshet was particularly late in the year, most of the fish examined at the fence had matured to a considerable extent; approximately 20% were silver, 60% had some coloration, and 20% were dark brown. From 10 to 15% of the fish were judged to be ripe, based on the amount of pressure required to extrude gonadal products, and 4 adults released eggs or milt while being processed. During 1986 and 1987, about 10 spawning events were observed between the fence and the mouth of the river.

During 1985, unseasonably cold temperatures caused the surface waters to freeze between Nov. 10 and Dec. 2. A solid layer of ice covered all surface waters adjacent to the fence, thus preventing further migration. On several occasions, fence crews broke the ice, seined out all coho from the lower pools, and released them in pools above the fence. Catches reported on November 13, 21, 22 and 25, correspond to the numbers of fish handled by the crew while the stream was frozen.

Each year, some coho aggregated in the pool located 30 m downstream from the fence, particularly during periods of low flow. Seining was required during late November 1986 and 1987 to ensure that the fish holding below the fence could be examined, marked and released prior to the next flood.

Floods occurred at least once every year during the 1986-1988 period. During floods, very little debris, in the form of logs and branches, was transported downstream. This allowed the crew to maintain the fence upright under considerable flow, except under conditions of high water levels (>65 cm), high water velocity (>170 $cm \cdot s^{-1}$), or high discharge rates (>22 $m^3 \cdot s^{-1}$). During this study, the duration of floods per season increased from 6 d in 1986, to 18 d in 1988, in accordance with the mean seasonal discharge (Table 4.1). This caused an increase in the frequency of incomplete counts obtained each year.

Fence counts and visual observations conducted at the fence, indicated that each year, over 80% of the returning coho enter the stream during the 2 week period following the first freshet.

Small pulses of migrants were detected as late as December 8 (1985), but usually, the vast majority of adults had moved upstream by the end of November. It is doubtful that significant numbers of adults enter the river during December. This observation is supported by numerous stream surveys conducted which showed that silver, immature cohos are rarely captured late in the season.

Adult counts were highest in 1986 (4408), and lowest in 1987 (750), indicating a sixfold variation in the number of adults intercepted at the fence during this study (Table 4.1). Jack counts were considerably less variable, ranging from 191 in 1986, to 528 in 1987. Jack to adult ratios based on fence counts underestimate the actual ratio in the population because some jacks escape through the fence panels. Field observations suggested that about 20% of the jacks present swam through the panels each year without being enumerated. Catch figures were adjusted to account for the fraction undetected, and provide preliminary estimates of jack to adult ratios. The ratio was lowest in 1986 (1:18), intermediate in 1985 and 1988 (≈1:9), and unusually high in 1987 (1:1.1) due to the relatively low adult returns.

All smolts released from local hatcheries during 1985 were fin clipped (L.V or R.V). The total absence of fin clipped jacks and adults in the samples of fish examined at the fence during 1985 and 1986, indicates that very few hatchery fish stray into this system. Further examination of the CWT recovery data supported this observations (Section 6.1)

During each season, a variable portion of the fish examined each day was marked prior to release. The proportion of adults marked increased from 58% in 1985, to 82.1% in 1988, while the corresponding proportions among jacks increased from 12.4% to over 95% during the same period. None of the marked fish were ever reported to have been recovered in neighboring streams, where escapement levels were being monitored by DFO personnel. Therefore, it was assumed that adults and jacks form Black Creek did not emigrate to other streams once they had moved beyond the fence.

Trent River

Each year, coho began aggregating in the lower sections of the river in early October, prior to the first freshet. At the beginning of each season, negligible stream flows prevented these early migrants from moving beyond the tidal waters. Early migrants could occasionally be seen from the stream bank, moving upstream with the flow, holding below the highway bridge during high water, and retreating back to sea with the ebb. Installing the fence disrupted the normal movement patterns, and forced the fish to hold below the fence at high water.

Field observations suggested that decreasing barometric pressures, tidal changes and increasing water levels induced coho to move upstream. Prior to the first freshet, coho were often caught during periods of receding tides and low stream flows. All fish captured, processed and released under these conditions would aggregate below the highway bridge, and hold until there was sufficient flow to proceed further. Thus, by having the fence located in tidal waters, a substantial number of fish could be examined and marked before the first freshet (Fig. 4.2).

Coho released before the first freshet could move upstream if at least 12 cm of water flowed through the channels connecting various pools. Even during the unseasonably dry periods of 1986, there was sufficient flow for the migration to begin about 2 weeks prior to the first major freshet. As a result, fish released early in the season never spent more than 3 to 4 d below the highway bridge before moving upstream.

With the arrival of the first freshet, large amounts of forest debris are transported down the Trent River. Water levels usually increased abruptly following periods of heavy rain, and a 0.5 m increase in water level over a 4 h period was common. As a result, it was not usually possible to

maintain the fence upright during the first freshet. Even if 6 persons were available to clean the fence continuously, the fence generally had to be collapsed a few hours after the flood began. In the absence of debris, the fence could not be kept upright under conditions of high water levels (> 87 cm), high water velocity (> 2 $m \cdot s^{-1}$), or high discharge (> 37 $m^3 \cdot s^{-1}$).

During 1985, slippage in the cable anchors necessitated a partial collapse of the fence during periods of moderate to heavy flows. During the following seasons, both the seasonal discharge rates and the frequency of floods increased substantially (Table 4.2). These conditions required that the fence be collapsed intermittently for at least 2 weeks each season. Each year, fence crews observed some coho (<100) moving upstream while the fence was collapsed, and on some occasion, a few coho being passively transported out to sea. As a result, only a partial escapement enumeration was possible each year.

During 1985, surface waters in areas adjacent to the fence were frozen between November 10 and December 2. The catches reported on December 3 were obtained by seining coho held below the fence. Seining was also conducted during 1986 on November 8, 14 and 15, to obtain brood stock for the hatchery, and ensure that the remaining fish could be examined, marked and released before the anticipated flood. Seining operations were also conducted during November in 1987 and 1988 for the same purposes.

Fence counts and visual observations conducted at the fence suggest that this population has a protracted run. The adult migration occurred over a 4 to 5 week period in 1985 and 1986, and over a 2 to 3 week period in 1986 and 1987. Each year, coho showed a tendency to enter the river at irregular intervals, prior to, and during the first flood. Coho captured after November 23 were usually those that had held below the fence, and rarely included silver coho that had recently arrived. Thus, most of the migration occured each year before the last week of November. It is doubtful that significant numbers of coho entered the river during December. This observation is supported by the results of numerous stream surveys conducted which showed that silver, immature cohos are rarely captured late in the season.

Adult counts were highest in 1986 (1076) and lowest in 1987 (194), indicating a fivefold variation in the number of adults intercepted at the fence (Table 4.2). Jack counts were even more variable, ranging from 12 (1987) to 115 (1988). Field observations indicated that about 35% of the jacks present managed to swim through the trap and fence panels. Fence observations, and snorkel swims conducted further upstream by other investigators during 1988 revealed that an unusually large number of jacks (≈ 80) escaped undetected early in the season while the fence was in operation (R. Bocking, pers. comm.), which represented about 400% of the total trap count up to that date.

The proportion of jacks lacking a fin (L.V, R.V or adipose) was usually smaller than the corresponding proportion among their adult siblings (Table 4.2). Such discrepancies can be attributed in part to the small number of jacks examined. In addition, the relatively large number of hatchery strays among the adult sample had a confounding effect. During 1986, adult strays from neighboring hatcheries were identified primarily by their missing ventral fin, as over 90% of these fish had been fin clipped prior to release. Adults lacking a left ventral fin made up over 47.6% of the total fence count. The magnitude of this contribution emphasizes the importance of accounting for the abundance of hatchery fish, before estimating the escapement levels and tagged proportions of the remaining fish of Trent River origin. Without the presence of a characteristic fin clip, the contribution of hatchery strays to the total escapement during 1985, 1987 and 1988 could only be determined from the identification of the coded-wire tags recovered (Section 6.1).

Each year, a substantial number of adults caught at the fence were retained to supply the local hatcheries with brood stock. The proportion of the adult fence catch used for this purpose

was lowest in 1986 and 1988 (8%, 11%), but higher in 1987 (16%), and 1985 (20%). In addition, a few injured adults were retained each year for CWT identification.

During 1985, about 1/3 of the adults and jacks were released without marks, but nearly all adults and jacks were marked prior to release in subsequent years (Table 4.2). However, not all marked fish remained in the river. During 1986,1987 and 1988, field crews at the fence observed a few coho moving downstream during the first major flood. Each year, after the flood, several marked fish were found in neighboring streams. On November 25, 1986, 143 marked adults were recovered at the Puntledge hatchery, and 2 marked adults were caught in Roy Creek. On November 30, 1987, 6 marked adults cohos were recovered at the Puntledge hatchery. In addition, one unmarked adult that had been tagged with an external Peterson disk in the headwaters of the Trent River, was recovered in the headwaters of the Tsolum river by Puntledge hatchery staff. During 1988, 7 marked adults and 1 marked jack were recovered at the Puntledge hatchery on November 4. A few days later, 2 marked adults were recovered in Roy Creek, and 1 marked adult was found in a small adjacent creek. Each year, several other systems in the region were surveyed by DFO personnel, but no other marked fish were reported.

The number of marked fish recovered at the Puntledge hatchery was expanded by 25% to account for the sampling regime used at the hatchery[8]. As a result of this adjustment, the number of marked fish that emigrated from the Trent River during the 1986, 1987 and 1988 seasons was estimated to be 181, 8 and 12 adults respectively. This represents 16.8%, 4.1% and 3.3% of the adults counted at the Trent River fence each season. Based on the time of recovery and the occurrence of the floods on the Trent river, it was assumed that the marked fish left the stream on Nov. 18, 1986, Nov. 11, 1987, and Nov. 1, 1988.

Fence counts were adjusted to account for the emigration of marked fish from the Trent River each year. For 1986, 82% of the emigrants were assumed to lack a left ventral fin, which represents the fin clipped fraction among the smolts released at the Puntledge hatchery in 1985. It was also assumed that 6.4% of the fin clipped adults that emigrated during 1986 lacked a adipose, as this represents the tagged proportion among fin clipped adults enumerated at the Trent River fence that year. Fence statistics on the number of fish released, marked, and the number of fish lacking a particular fin were reduced accordingly. The proportions in each fin clipped category were recalculated to provide preliminary estimates of the size and composition of the remaining group (Table 4.2). Similar adjustments were made to the 1987 and 1988 counts, except that the proportions in each fin clipped category was not recalculated, given the low number of emigrants observed.

Chum salmon arrived at the fence mostly around mid-November each year. Marks were applied to all chums captured at the fence, but this was usually an insignificant portion of the total run, since the vast majority of adults either moved upstream during floods, or remained below the fence where they spawned and died. Some spawning events were observed throughout the 600 m section below the fence, but most spawners used the section between the old trestle and the railroad bridge. Given this situation, escapement levels were based on stream survey counts exclusively (Section 4.5).

French Creek

Prior to the first freshet, some 10 to 50 coho were seen each year near the stream mouth. During 1986 and 1987, delays in the arrival of fall rains forced these fish to hold in the pool under

[8] Each year, a substantial portion of the adults returning to the Puntledge hatchery remain in the river, and are not sampled at the hatchery. Field observations indicate that this fraction ranges from 25% to 35% of the hatchery escapement (H. Genoe, pers. comm.).

the highway bridge. During 1985 and 1988, sufficient stream flows allowed most early migrants to move into several fresh water pools above tidal reaches. A few adult coho (< 12) died each year while holding in the lower sections.

Approximately 12 to 16 cm of water over the sill was sufficient for coho to swim up to the fence. As a result, several hundred coho were able to migrate upstream in 1985, eventhough freshets never occurred during the season (Fig. 4.3). During the following seasons, water levels increased more abruptly, and coho were mainly caught at the fence during the first freshet.

Fence operations did not seem to interfere with the upmigration, and only minor delays were caused by natural factors. During 1985, some coho held for a few days in the shallow pools just below the fence, and some late migrants were held downstream under the ice from Nov. 23 to Dec. 5. Coho were captured with seines in the lower pools only during December 1985, after the ice had thawed, to collect brood stock for the hatchery.

Substantial amounts of leaf material were transported downstream even when stream flows were moderate. Up to 6 workers were required to continuously clean the fence panels during the first freshet. If much debris was present, the fence had to be collapsed when discharge rates exceeded 5 $m^3 \cdot s^{-1}$. By contrast, under clear conditions, the fence could be maintained upright until discharge rates reached 18 $m^3 \cdot s^{-1}$. Floods conditions occurred at least once a year during the 1986-1988 period. As a result, only a partial enumeration was conducted each year. Incomplete daily counts were only obtained on a few occasions during 1985 and 1986, but were nearly three times more frequent during 1987 and 1988.

Over 85% of the coho enumerated each year were captured within 5 d from the first period of high water (>14 cm). Fence counts reported after this period usually consisted of fish caught in the lower pools by hatchery volunteers, and rarely included newly arrived fish. Surveys conducted in the lower sections indicated that nearly all coho had moved upstream by the end of November. It is doubtful that significant numbers of adults entered the river during December.

During this study, fence counts of adult coho ranged from 76 (1987) to 937 (1988), indicating a twelvefold variation in the number of adults intercepted at the fence (Table 4.1). Jack counts were considerably less variable, ranging from 26 (1986) to 109 (1988). Field observations suggested that about 25% of the jacks present at the fence moved through the panels undetected. By accounting for the undetected portion, preliminary estimates of the jack to adult ratios were obtained. The ratios were lowest in 1985 and 1986 (1:11, 1:19), intermediate in 1988 (1:7), and unusually high in 1987 (1.5:1). Such trends were very similar to those observed at Black Creek.

The absence of jacks lacking a left ventral fin among the 1985 sample indicated that hatchery fish did not stray in large numbers to this stream. This was confirmed during 1986, as only 4 out of the 625 adults examined at the fence lacked their adipose fin. Assuming that these fish did not naturally lack their adipose fin, then hatchery strays made up less than 1% of the adult escapement.

A substantial portion of the adults caught each year were retained to supply the local hatchery with brood stock. The proportion of the total fence catch used for this purpose each year during the 1985 to 1988 period, was 14%, 11%, 25%, and 9% respectively. No other live adults were retained for other investigations or CWT recovery.

During 1985, less than 1/4 of all adults and jacks released were marked because of various constraints. However, during subsequent years, nearly all adults and jacks released from the fence were marked. None of the marked fish were ever reported to have been recovered in neighboring streams where escapement levels were being monitored by DFO personnel.

Only a few chum salmon were caught at the fence each year (Table 4.3). Field surveys indicated that most chum spawned in the lower 1 km section of the stream. Each year, some 10 to 30 chum spawners were counted in that sections.

4.5 STREAM SURVEY DESIGN AND METHODS

Each year, surveys were conducted throughout the adult migration and spawning periods to determine the marked proportions among each population, to collect coded-wire tags, and to obtain information on the demographic traits of each spawning population.

Preliminary field surveys were conducted in 1984 to determine the location of spawning grounds and holding pools, evaluate the accessibility of various areas, identify potential sampling sites, and obtain information on the relative distribution coho in each stream. Field observations revealed a considerable amount of spatial and temporal variation in coho densities. High densities were observed at specific sites previously identified by local DFO biologists, which supported the notion that coho tended to aggregate in certain locations year after year. These observations served as the basis for the selection of a sampling program for this study.

Howard (1948) and Scheafer (1951) noted that the non-uniform distribution of marked ratios could influence the mark-recapture estimates. Howard (1948) suggested that sampling for marks should be distributed over time and areas to obtain a representative sample of the whole population. Many statistical methods require that samples be taken at random in space and time to eliminate bias. However, sampling at randomly selected times and areas was considered to be inefficient and impractical in the present situation, due to the inaccessibility of certain areas, and the difficulty of sampling under certain conditions.

Hurlbert (1984) noted that for ecological studies, interspersion of samples is often a more practical criterion than randomization, and generally serves the same purpose. With this general approach in mind, one sampling area was selected in each of the upper, middle and lower sections of each system. Within each area, specific sampling sites were identified based on the apparent availability of fish, accessibility, and suitability for electroshocking. The sites chosen consisted mainly of shallow holding areas, and stream banks, scattered adjacent to, and away from the spawning grounds. During each survey period, efforts were made to patrol all areas, and sample in at least one site per area.

During each sampling event, attempts were made to sample over a distance of about 0.5 km within each general area. At times when densities were low, longer distance were covered in an attempt to recapture at least 4 marked fish (R) per sample, so that the confidence intervals of R would not include 0, which minimizes the possibility of statistical bias (Ricker 1975). It should be noted in most instances, a variable portion of the total number of fish present in each area escaped without being examined. As a result, catch per unit effort statistics based on the sampling data are not always indicative of the relative abundances in each area.

For purposes of consistency, a single crew conducted nearly all surveys done in each stream during this study. Live coho were captured mainly by means of an electroshocker using the minimum electrical output necessary to temporarily stun the fish. Each coho captured was measured, sexed, and examined for marks and missing fins. After examination, a secondary mark was applied to the operculum by means of a hand-held paper punch, and the fish was released after a brief recovery period. All carcasses recovered were examined for marks, given a secondary mark, and left in the stream. Heads were only removed from coho that had spawned or died, and

that lacked an adipose fin. All heads recovered were labelled, placed in a plastic bag, and frozen at the end of the day. All heads were subsequently sent to the DFO Head Recovery Lab for CWT identification.

On some occasions, large seines were used to collect coho holding in deep pools. Ripe females were usually kept to supply the local hatchery with brood stock, and most of the remaining coho were processed according to the above method. Surveys were usually terminated between Dec. 15 and Dec. 25 when fish densities appeared to be too low to justify further sampling. Field observations suggested that over 95% of the spawners had died and disappeared by December 25 each year.

4.6 MARK INCIDENCE AND SPAWNER DISTRIBUTION

Black Creek

The majority of the surveys conducted during 1986-1988 period were done in the middle and upper reaches of the system, mainly because the lower reaches could not be surveyed under high water conditions. The opposite situation prevailed in 1985, and no samples were collected in the headwaters, because the unusually low water conditions prevented adults from reaching the upper spawning grounds. Approximately eight surveys were conducted each year, but substantial numbers of coho were only captured on certain occasions, as determined by the period of stream residency and escapement levels.

The number of adults examined for marks each year ranged from 41 to 169, while the number of jacks examined ranged from 5 to 21 (Table 4.4). The proportion of marked adults recaptured each year ranged from 2% to 5%, while the proportion of marked jacks recaptured ranged from 1% to 4%. The mark proportions among adult samples ranged from 27.9% to 90.2%, indicating that a substantial portion of the adult escapement was marked each year. By contrast, the mark proportions in the jack samples was about 1/3 to 1/2 of the adult proportion observed that year. Recapture rates of jacks and adults are not directly comparable, since the number of marked adults and jacks released each year differed considerably.

Within a given year, there was considerable variation in the mark proportions between samples. Based on field observations, no evidence was found to indicate that there was significant and consistent differences between the mark proportions of samples collected in each sampling area. In addition, no evidence was found to indicate that specific segments of the run aggregate or spawn predominantly at certain locations. Thus, it appears that the marked and unmarked fish distributed themselves throughout the system in a fashion that was not affected by their time of arrival at the fence. Mark proportions generally decreased throughout each season[9], mainly as a result of the non-proportional marking regime used at the fence (Fig. 4.1). The slight increase in the mark proportions observed during the early part of 1985 was attributed to the substantial releases of marked fish late in the season.

Sufficient numbers of adults and jacks were examined each year during stream surveys to obtain estimates of the proportions of adults and jacks lacking an adipose, left ventral or right ventral fin ($P_{ad,s}$, $P_{lv,s}$, $P_{rv,s}$). Reference to Tables 4.1 and 4.4 shows some discrepancy between the proportions of adults and jacks lacking an adipose or left ventral fin based on stream surveys, and the corresponding proportions based on fence counts ($P_{ad,f}$, $P_{lv,f}$, $P_{rv,f}$). Data from both

[9] In order to minimize the distortions caused by small sample sizes, samples with fewer than 4 fish or 3 recoveries were combined with other samples taken during the same week.

sources were entered in 2 x 2 contingency tables, and analyzed by means of a chi-square test corrected for continuity (Table 4.7). No significant differences were found between the proportions of tagged jacks estimated from fence counts and stream surveys. Significant differences were not detected between the corresponding adult proportions obtained from both sources during the 1985-1987 seasons, but were detected during the 1988 season.

The nature of the factor accounting for the 1988 results could not be determined with certainty. No evidence was found to indicate the presence of tagged fish from other systems at the fence, or of emigration of tagged fish during floods. It was hypothesized that the early migrants enumerated at the fence had a higher proportion of tagged fish than the late migrants which entered during the flood, but further examination of each sample taken showed no apparent increase or decrease among individual estimates of $P_{ad,s}$ and $P_{ad,f}$ through time. Thus, in the absence of evidence to indicate that the stream survey samples were not representative of the actual marked proportion in the population, sampling statistics from both sources were pooled within each season to determine the minimum escapement levels, and the proportions that were tagged or fin clipped. These estimates were calculated separately for each age group as follows;

$$E_{min,c} = \sum C_{fence,c} + \sum C_{stream,u,c} - \sum R_{outside,m,c} \quad (4.1)$$

$$P_c = \frac{E_{min,c}}{\sum_c E_{min,c}} \quad (4.2)$$

where;

$E_{min,c}$ = Minimum escapement by category (l.v, r.v, ad, or total)
$C_{fence,c}$ = Daily fence count of fish by category
$C_{stream,u,c}$ = Stream survey counts of unmarked fish, by category, which were not previously counted at the fence[10].
$R_{outside,m,c}$ = Recoveries of marked fish in other streams by category
P_c = Proportion of observed escapement in each category

Given the relatively small number of fish captured during stream surveys, and the absence of emigration of marked fish to other streams, the estimates based on pooled data (Table 4.8) do not differ substantially from the estimates based on fence counts.

Stream surveys revealed considerable year to year variation in the distribution of spawners, and the time lapse between stream entry and spawning period. During 1985, spawning was mostly confined to the stream section between Northy Lake and the fence, since low water levels and ice coverage prevented access to most of the upper reaches. Spawning activity was not noticed until 10 d after the first day of adult migration. By contrast, spawning activity was detected as soon as the fish entered the stream during 1986 and 1987, and to a lesser extent in 1988. During the 1986 and 1987, spawning activity was mainly confined to the areas adjacent to the Duncan

[10] This was set to the number of fish, in each category, lacking a primary and secondary mark, if the number of fish released at the fence without marks was negligible (<20 or so). When this condition was met (as in most cases), the possibility that a fish gets counted twice was considered to be negligible. In cases where this condition was not met (for instance B.C '85, '86, '87), the number of fish in this group was set as 0.

Main Rd., in the lower end of Millar Cr., in the 500 m section below the bridge at the end of Endall Rd., and throughout the 1 km section above the fence. During 1984 and 1988, a larger portion of the spawners were found in the headwaters. Very little spawning activity was detected in the small tributaries near Dzini Rd, except during 1986. Each year, spawning activity peaked during late November and early December. Nearly all adults examined after December 10 were spent.

During 1987, the unusually large jack to adult ratio detected at the fence, was also noticeable during the spawning period, as most spawning females were paired with jacks. During other years, jacks were occasionally observed in the vicinity of females, but were rarely observed to be paired with one during a spawning event.

Some of the Petersen and spaghetti tags applied at the fence during 1987 and 1988 were recovered each year during both stream surveys and the instream indexing surveys. For purposes of consistency, only tags recovered during the indexing surveys were used to generate tag depletion curves. Estimates of the period of stream residency were then obtained by integrating the curve and dividing it by the number of tags applied (AUC method, Bocking *et al.* 1988). The estimated average period of stream residency of adults was 10.3 d in 1987 (Bocking *et al.* 1988), and 11.2 d in 1988 (R. Bocking, pers. comm.).

Trent River

Considerable effort was required to collect coho with an electroshocker due to the presence of many log jams, deep pools, and wide channels which provided shelter to the fish. As a result, about 10 surveys were conducted each year, but substantial catches were not obtained on each survey. On several occasions, samples obtained at various sites on a given day had to be combined in order to generate the ratios required (Table 4.5). Large samples were usually obtained by seining various pools in the headwaters, or by electrofishing near the spawning grounds.

The number of adults sampled during the 1986 stream surveys represented a relatively small proportion (6.3%) of the total fence count, but this proportion was substantially larger in other years, ranging from 33% in 1985, to 70% in 1987. Stream survey samples provided a relatively large amount of additional information on the proportion of adults in each fin clipped category, which was used to test various hypotheses on the distribution of adults within the river.

The recovery rate of adults marked at the fence ranged from 5% to 16%, while the recovery rate of jacks ranged from 0% to 20%. The recovery rate of marked adults was not consistently greater than for jacks, but the factor(s) responsible for this pattern could not be determined with certainty, given the large differences between the number of marks released. The overall mark ratios for adults was relatively high in 1986 (53.7%), but substantially lower in other years, ranging from 12% to 28%. Marked ratios among the jack samples was considerably more variable, ranging from 0 to 50%. Such figures indicate that the marking objective was generally not met in this stream.

Within each season, there was considerable variation among the mark proportions observed during the surveys (Fig. 4.2). Marked ratios generally decreased during the early surveys, following the first flood when unmarked fish entered the river. Marked fish released in the early, middle or late stages of the run were subsequently recovered at sampling sites throughout the river. Statistical comparisons of the mark proportions obtained at different sampling sites was not possible for lack of sufficient sample sizes to test for time and site effects. However, no obvious differences were noticed between the spatial distribution marked or unmarked fish within the river.

Reference to Tables 4.2 and 4.5 reveals some discrepancies between the proportions of jacks or adults lacking a particular fin in samples taken at the fence and during stream surveys. Chi-square tests revealed significant differences between the relative abundance of fin clipped (L.V.) adults in samples from both sources during 1986, even after adjusting the fence counts for emigration losses. Significant differences in the relative abundance of fin clipped adults were also detected between samples from the upper and lower sections of the river ($\chi^2 = 5.5$, $p = 0.02$). Stream survey samples from sections upstream of China Creek contained relatively fewer fin clipped adults than samples from lower sections, indicating that hatchery strays tended to remain in the lower reaches of the river. Thus, the discrepancies observed between the $P_{lv,f}$ and $P_{lv,s}$ were mainly attributed to the fact that the stream survey samples were mainly taken in headwaters. There was also a definite reduction in the relative abundance of fin clipped adults in samples taken before and after the flood, which supports the notion that some fin clipped adults emigrated from the river during the flood. However, this reduction was not sufficiently large to be statistically significant ($p = 0.175$), and therefore all stream survey samples were used for estimating the fraction of the stream population that was fin clipped. Tagged proportions among stream survey samples were larger than those observed at the fence, but the differences were not statistically significant ($p = 0.898$). Tagged proportions in samples taken before the flood were not significantly different than among those taken after the flood ($p = 0.930$). Such results could be expected irrespective of the contribution of hatchery fish, if the tagged proportions among hatchery and non-hatchery adults were similar. Accordingly, tagged proportions among adults of Trent River origin, and among the adults returning to the Puntledge river were both estimated to be within the 10-15% range (Table 6.3, and MRP database records). In view of these facts, sample data from both sources were pooled to provide estimates of the proportions of adults in the river that belong to each fin clipped category.

Similar results were obtained in 1987. Significant differences in tagged proportions were detected between the samples from both sources (fence, stream), even after adjusting the fence counts for emigration losses (Table 4.7). Significant differences in the relative abundance of tagged adults were detected between samples taken above and below China Creek ($\chi^2 = 5.659$, $p = 0.017$), with the headwater samples containing larger proportions of tagged adults. It is thus hypothesized that most of the adults in the headwaters were of Trent River origin, of which a relatively high proportion were tagged. By contrast, adults of hatchery origin with lower tagged proportions tend to remain in the lower reaches of the river, where they cause a localized reduction in tagged proportions. In support of this hypothesis, the tagged proportions among adults of Trent River origin, and among adults returning to the Puntledge hatchery were estimated to be approximately 36% and 7% respectively (Table 6.3, and MRP database records). Thus, the significant differences obtained when comparing stream and fence samples, are mainly attributed to the fact that stream samples were taken mainly in the headwaters, and thus misrepresented the overall contribution of hatchery strays in the river. Since adults from all locations contribute to the spawning populations, pooling sample data from both sources was justified to estimate the overall composition of the stream population.

With regards to 1988, the relative abundance of tagged adults was also higher in stream survey samples than was observed at the fence, but the difference was not statistically significant (Table 4.7). Fin clipped proportions among samples from both sources were almost identical, which was expected, since fin clipped adults returning that year were not of hatchery origin (as in 1986).

Similar trends were observed for jacks. The tagged proportions among jacks were always greater in stream survey samples, than in samples taken at the fence, but the difference was statistically significant only in 1987. It should be noted that the only known case of jack emigration to the Puntledge River hatchery was reported during 1987. Approximately 12% of the jacks examined at the Puntledge hatchery during 1987 were tagged (MRP database), which is

much lower than the 80% figure obtained during stream surveys. The presence of hatchery jacks with proportionally fewer tagged individuals could account for the low tagged proportions observed at the fence. The subsequent departure of hatchery jacks from the Trent River would increase the tagged proportions among the remaining jacks, and account for $P_{ad,s} > P_{ad,f}$ as observed. Alternatively, jacks of hatchery origin might also occupy lower sections of the river, as was observed for adults, but there was not sufficient samples available to test this hypothesis.

In view of the above facts, minimum escapement levels, fin clipped and tagged proportions among adults and jacks were calculated according to Eq. 4.1 and 4.2 for all years, using fence counts adjusted for emigration losses (Table 4.8).

Stream surveys revealed that marked fish released at the fence could distributed themselves throughout the lower 3 km of the stream within 24 h after release, but usually required at least 48 h to reach the middle reaches (China Creek to Bloedel junction), and 72 h to reach the headwaters. Each year, a substantial number of coho were observed to aggregate in the lower reaches of the stream, in the middle reaches near China Creek, and in the upper reaches beyond the Elm trail near the the Bloedel Creek junction. It should be noted that adults have been observed in the mainstem, at least 1 km beyond the Bloedel Creek junction, but were never seen by the author in the lower section of Bloedel Creek.

On November 19, 1987, 9 d after the initial migration, 43 adults were seined from the pools below the Bloedel Creek junction, marked with Petersen disks, and released (Bocking *et al.* 1988). Based on the subsequent recovery pattern of these fish, it appeared that the majority of the fish remained in the general location of marking until spawning and death. One tagged adult was subsequently observed spawning in China Creek a few days later, indicating that adults can move downstream in search of spawning locations. Another tagged adult was recovered in the headwaters of the Tsolum river some 15 km away. Assuming that the extensive migration to the Tsolum river was not induced by the tagging, it appears that strayed adults can migrate several kilometers upstream before leaving.

Field surveys conducted during 1986 revealed that a considerable number of hatchery fish (identified by their missing ventral fin) that had strayed into the Trent River, remained to spawn and die (Table 4.5). In order to determine if hatchery and non-hatchery fish spawned together, efforts were made to capture adults that were paired together near reds, as well as adults that were in the process of spawning. Examination of the fish captured showed that hatchery adults were spawning with other hatchery fish, as well as non-hatchery fish. This observation indicates that there is a considerable amount of hybridization occurring in the Trent River. No attempt was made to dig out the reds to determine the extent of egg fertilization.

Field surveys indicated no apparent changes in the distribution of spawners from year to year. Spawning activity was observed mainly throughout the 1.5 km section above the old tressel, in the lower reaches of China Creek, and areas adjacent to the Bloedel Creek junction. In addition, isolated spawning events were observed each year throughout the system wherever spawning substrate was available. Spawning activity started around late October, usually peaked during the first week of December, and was observed as late as December 24. Field observations suggested that over 95% of the stream population had spawned and died by the third week of December. In some years, a few (<3) silver bright coho with ectoparasites were captured in late December, indicating that some coho enter this river late in the season.

A fraction of the external tags applied in the headwaters during 1987, and at the fence during 1988, were recovered during the stream surveys and the instream indexing surveys. Based on the tag recovery pattern observed during the later surveys, the average period of stream residency for adults was estimated at 11.0 d in 1987 (Bocking *et al.* 1988), and 8.9 d in 1988 (R. Bocking, pers. comm.).

Chum salmon were observed to spawn mainly between the railroad tracts and the estuary. Field observations and examination of the spawners suggested that the run occurred over a relatively short period of time, with the vast majority of spawners arriving in one large pulse. Deadpitching was not conducted, mainly for aesthetic reasons, given the proximity of residential areas. Instead, visual counts were made of the number of whole carcasses and live fish present throughout this area during the period of peak abundance. The counts obtained were then expanded subjectively to account for the number of partial carcasses, and the number of fish removed by predators or tides prior to the count. This enumeration method indicated that escapement levels were at their lowest levels during 1985 and 1988, with spawning populations of 500 and 450 adults respectively. Escapement levels were substantially higher in 1986 and 1987, with estimates of 1100 and 900 adults respectively.

French Creek

The majority of the surveys conducted between 1985 and 1988 were done in the upper and middle reaches of the stream, mainly because the holding locations in the lower sections were to difficult to sample properly. The temporal distribution of surveys, and the catches reported, reflect the period of spawner residency (Table 4.6). Relatively large catches were obtained in 1985 and 1986, when fence counts indicated intermediate levels of escapement. The low fence counts during 1987 were accompanied by unusually low densities of adults in the stream and low catches obtained. Large catches were also obtained in 1988, due in part to the substantial number of carcasses recovered at the fence.

The proportion of marked adults recaptured each year ranged from 9.3% to 13.8%, which was remarkably stable given the large year to year differences in the number of marks applied. The corresponding proportions for jacks were always lower, and ranged from 0 to 11.1%. This last observation was considered to be significant given that there was nearly twice as many marked jacks than marked adults in the stream during 1987. These results suggest that the catchability of jacks was much lower than that of adults. Additional support for this hypothesis was obtained from numerous field observations which also indicated that jacks were less susceptible to capture than adults. When seines were used to enclose certain stream sections, jacks were observed escaping through the small holes more often than adults. In addition, jacks were not immobilized as readily as adults when exposed to the electrical field generated by the electroshocker. As a result, a larger fraction of the jacks present at some locations were observed escaping during the sampling periods. Thus the jack to adult ratios obtained during the surveys may not accurately reflect the relative abundance of jacks.

Within a given season, there was considerable variation in the mark ratios obtained (Table 4.6). Samples were too irregularly spaced to be contrasted statistically for spatial trends, but field observations revealed no evidence to indicate that marked fish distributed themselves in a particular fashion in the stream. However, mark proportions generally decreased through time each year, presumably due to the influx of unmarked fish during floods (Fig. 4.3). Mark proportions obtained during 1985 did not exhibit this trend because floods did not occur, and unmarked fish entered mostly during the brief period of partial enumeration. On an seasonal basis, marked proportions among adults increased from 8.9% to 81.8% during the 1985-1988 period, while the jack proportions increased from 6% to 41%. This was mainly attributed to increased levels of efforts during the enumeration period, rather than improvements in trapping efficiencies.

During the 4 year period, the number of adults captured during stream surveys accounted for 15% to 26% of the total fence counts, while the jack catches accounted for 4% to 35% of the total jack count. Stream samples provided a large amount of additional information on the proportion of adults and jacks in each category. Reference to Tables 4.3 and 4.6 reveals some

discrepancies between the tagged or fin clipped proportions observed at the fence and during stream surveys. Chi-square tests revealed no significant differences between the $P_{ad,f}$ and $P_{ad,s}$, or between the $P_{lv,f}$ and $P_{lv,s}$ for adults or jacks within any given season (Table 4.7). Therefore, minimum escapement levels, and estimates of the proportion of fish in each category were calculated according to Eq. 4.1 and 4.2 (Table 4.8).

Stream surveys indicated that coho usually distributed themselves throughout the lower and middle sections within 24 h after passing the fence, but at least 48 h was required to reach the upper sections. However, substantial variation to this general pattern were observed during this study. Low water levels and debris build-up at the fishway often delayed access to the upper sections, at times for as much as several days. During 1985, coho moved into the lower sections relatively early in the season, where they remained in the deep pools and under log jams for approximately 2 weeks before moving further upstream. Between November 15 and December 15, low water levels and ice cover interfered considerably with movements within the middle sections of the stream , and prevented coho from reaching the headwaters until late December. During the 1986-1988 period, coho entered the stream later in the season, and moved into the spawning areas more rapidly.

Most of the spawning activity observed took place in the upper reaches along Winchester Rd. and Grafton Rd., near the junction of the East and West fork, throughout the 1 km section adjacent to the powerline crossing, and in areas between the fence and the river mouth. Pronounced year to year differences were observed in the degree of utilization of the spawning areas. Most of the spawning activity observed took place in the headwaters during 1984, 1985 and 1988, in areas adjacent to the junction and below the fishway during 1986, and in the vicinity of the powerline crossing during 1987. Isolated spawning incidents were also witnessed sporadically throughout the accessible areas each year.

Year to year variation in spawning times were also observed. Based on the appearance and condition of the adults examined, peak spawning activity appeared to occur at an earlier date each year. Spawning activity peaked around December 17 during 1984 and 1985, around December 8 during 1986 and 1987, and in late November during 1988. It should be noted that water temperatures also increased progressively during this period, from and average of 4.2°C in 1985, to 7.5°C in 1988.

Some of the spaghetti tags applied at the fence in 1988 were recovered during both stream surveys and the instream indexing surveys. Based on the tag recovery pattern observed during the indexing surveys, the average period of stream residency for adults was estimated at 13 d (R. Bocking, pers. comm.).

Chum spawning activity was mostly confined to the lower reaches of the stream, extending from intertidal waters to the fence itself. On some occasions chum spawners were captured further upstream near the powerline. Crude estimates of chum escapement based on the densities observed indicated that less than 100 chum spawned in this stream each year.

5.0 ESTIMATION OF RUN SIZES

The multiple censuses conducted each year provided some information on the the distribution and temporal trends of mark proportions. The traditional approach of combining the sampling data for pooled Petersen estimates causes a loss of information on this variability. Given

the stochastic nature of the mark-recapture process, maximum likelihood estimators are more suitable for drawing inferences about population sizes (White *et al.* 1982). Such estimators can use successive mark proportions to update the estimate of abundance (N) from one sample to the next, and assist in evaluating the credibility of the alternate levels of abundance hypothesized (N's).

Since serially numbered tags were not used in the present study, only a limited amount of data was obtained on the recapture histories. The available data was considered insufficient to rely upon traditional open population models of the Jolly-Seber type, for estimating escapement levels. Therefore, two recently developed maximum likelihood estimators were used for this purpose. Both of these models utilize the mark-recapture data collected, but do not require information on the recapture histories for estimation purposes.

Escapement estimates were first generated by means of a simple Bayesian algorithm proposed for estimating abundance in closed populations. In view of the uncertainty associated with the assumptions concerning closure, escapement estimates were also generated by means of an innovative, recursive estimation procedure, which accounts for potential mortality and immigration that can operate during the survey period. Only a brief description of the underlying structure of each model, and the results obtained are presented here. Additional details on the structure, applicability and relative performance of each model have been reported elsewhere (Gazey and Staley 1986, Labelle 1990).

5.1 ABUNDANCE ESTIMATES USING CLOSED POPULATION MODEL

Description of Bayesian model

The closed population model used in this study was developed by Gazey and Staley (1986). The estimates generated by this model are comparable to those obtained by traditional Schnabel type models when sample sizes are sufficiently large, but the estimates are more precise under conditions of small sample sizes and low recovery rates (Gazey and Staley 1986). This model determines the likelihood of a population size based on the joint probability distribution of the mark proportions observed during successive sampling events. Assuming that the mark-recapture data are available for each age group, Gazey and Staley (1986) propose the following structure;

M_t = Total number of primary marks in the river at the start of the t^{th} stream survey
C_t = Number of coho captured during the t^{th} stream survey
R_t = Number of primary marks recovered in the sample on the t^{th} stream survey

Provided that certain conditions are met (see next section), and that marked fish captured are released after examination (sampling with replacement), then the probability that a sample (C_t), contains a specific number of primary marks (R_t), given a specific population level (N_i), is described by the binomial distribution;

$$P(R_t|N_i) = \binom{C_t}{R_t}\left(\frac{M_t}{N_i}\right)^{R_t}\left(1-\frac{M_t}{N_i}\right)^{C_t-R_t} \qquad (5.1)$$

According to the Bayesian view, the only sampling information available is contained in the set of M_t, C_t, and R_t, obtained during the T stream surveys. Since the samples are independent of each other, the probability of observing all the R's given some population level N_i is ;

$$P(R_1, R_2, R_3, R_t | N_i) = \prod_{t=1}^{T} P(R_t | N_i) \tag{5.2}$$

The hypothesized population (N_i) is not known, but must be equal to, or exceed the number of adults enumerated, or the number of marked fish present at the time of sampling (t);

$$N_i \geq N_{enumerated} \geq M_{t,stream}$$

Initially, it must be assumed that there is a an equal probability (P) that the actual population size can correspond to any discrete population level (K) considered possible. This is represented by a non-informative discrete uniform distribution as follows;

$$P(N_i) = \frac{1}{K}$$

Since the hypothetical population sizes (N_i to N_k) constitute a set of mutually exclusive events with non-zero probabilities, of which one must occur, then equations 5.1 and 5.2 can be combined according to Bayes theorem, and reduced to;

$$P(N_i | R_1, R_2, .., R_k) = \frac{\prod_{i=1}^{T} \left(\frac{1}{N_i}\right)^{R_t} \left(1 - \frac{M_t}{N_i}\right)^{C_t - R_t}}{\sum_{i=1}^{K} \prod_{t=1}^{T} \left(\frac{1}{N_i}\right)^{R_t} \left(1 - \frac{M_t}{N_i}\right)^{C_t - R_t}} \tag{5.3}$$

Equation 5.3 describes the uncertainty of any hypothesized population level given the data on hand. By iterating over the hypothetical range of N_i's, a posterior distribution is generated which describes the likelihood of various population sizes relative to each other within the range selected (likelihood curve).

The mode of the posterior distribution is the population size for which $P(N_i | R...)$ is highest. This value corresponds to the maximum likelihood estimate of the sampling distribution, which can be considered as the best estimate of abundance (N^c, for close population model). The posterior distribution is also used to compute the range of plausible values for N^c. In the present context, these credibility regions were defined as the interval between *a* and *b* such that $P(a \leq N \geq b) = 1-$, where $\alpha = 0.05$. Values for *a* and *b* can be determined from the highest probability density region (HPD) such that $b - a$ is minimized.

Model assumptions

The above model must satisfy the same basic assumptions as Petersen-type estimators (see Seber 1982: 59). In order to determine the conditions under which the model is applicable, these assumptions were examined in light of the present context.

Assumption #1: The population is closed, both geographically and demographically (Otis *et al.* 1978), so that the population size remains constant. In the present investigation, coho salmon are marked as they enter each stream, which is viewed as the geographic entity of interest. Although some of the marked fish released at Trent river eventually emigrated to other streams, adjustments could be made to account for their departure, so that the geographic area remains bounded by the Trent River. Thus, geographic closure will be assumed to hold under such conditions.

In order to justify demographic closure, there should be no recruitment, emigration or death throughout the census period. In the present study, coho usually entered each stream over several weeks, but most of the run occurred within a shorter period centered around the first period of high water. At Trent River, marked coho also emigrated from the stream during the first flood. The effects caused by immigration and emigration could be minimized by using only census data obtained after the first flood for estimation purposes. This procedure would allow N to be estimated when the population is most stable.

With regards to natural mortality, Chapman and Junge (1956) noted that mark-recapture estimates are unaffected if mortality operates equally among the marked and unmarked individuals. Field surveys revealed no evidence to indicate that marked fish were more vulnerable to predators, or susceptible to significantly higher mortality that unmarked fish. However, the general reduction in the mark proportion observed in most years (Fig. 4.1 to 4.3) is indicative of some closure violation. When only samples taken after the immigration period were compared, no significant differences in mark proportions were found between the stream survey samples within each season, for all years, and all streams (Chi-square tests of census data from Tables 5.2 to 5.4). This indicates that violations can be minimized by using samples collected during that interval. It should be noted that one stream survey sample from the Trent River (16/11/85), which was not collected by the regular field crew, was questionable.

Assumption #2: All animals have the same probability of being caught in the first sample (i.e, at the fence). This assumption would be violated if there was selection for certain types of fish when primary marks were applied. Since intercepting and marking coho at the fence was mostly determined by hydrological conditions and their time of arrival, there was no active selection by the fence crews for particular types of fish during the marking stage. Small adults (<35 cm) are suspected to escape though the panels undetected (Section 4.3), but these individuals made up a negligible fraction of each adult population (Fig. 6.1).

However, fish moving upstream during periods of low flow were more likely to be enumerated and than fish moving upstream during floods. This fact could potentially translate into different mortality schedules between both groups, and account for the decreasing mark proportions observed in most years (Fig. 4.1 to 4.3). Evidence in support of this hypothesis was obtained from field surveys, which revealed that a few marked coho released early each season died before the arrival of unmarked fish during the flood. The loss of marked coho was particularly noticeable in years when there was large time gap between the start of the run and the first flood. The census data available were not suitable to test for differential mortality and quantify this process.

Chi-square analysis of 2 x 2 contingency tables of mark ratios by sex category showed no significant differences between the mark ratios of each sex group (Table 5.1), which failed to demonstrate that early migrants were predominantly males, or that there was selection during marking for a particular sex. Field observations revealed no evidence to indicate that early and late migrants had distinct distribution patterns in the stream. Field observations suggested that the catchability of jacks and adults differed (Section 4.4), so both age groups were treated independently during the estimation process.

Assumption #3: Marking does not affect the catchability of an animal. This assumption is met if marked and unmarked coho were equally detectable, and catchable during the electrofishing process. Equal detectability was ensured by using caudal or pectoral holes as marks, as opposed highly visible external tags. Both marked and unmarked fish appeared to be equally susceptible to capture by electroshocking devices during the sampling operations, but this hypothesis was not tested.

Assumption #4: Sampling during stream surveys was a random process. In order to fulfill this condition, attempts were made to sample in as may different sites as possible, within each sampling area, throughout the duration of the spawning period (Section 4.5). Still, the final sampling regime was to a large extent dictated by the prevailing hydrological conditions. This sampling regime was not truly random, the same objective was met by interspersing the samples.

Assumption #5: Animals do not loose their marks prior to sampling for recovery. Because of the type of marks used in this study, losses were considered to be negligible. During 1986, a small percentage (<10%) of the fish examined at French Creek were not clearly identifiable due to some erosion of the caudal fin. In such cases, each coho was arbitrarily classified as marked or unmarked based on the pattern of erosion, and the condition of the fish. In difficult cases, the fish was not included in the sample. However, these cases made up only a small fraction (< 0.5 %) of the total number of fish examined during the stream surveys, and the vast majority coho examined were clearly identifiable.

Assumption #6: All marks observed during stream surveys are reported. Efforts were made to minimize the possibility of misreporting. A single recovery crew conducted nearly all stream surveys since 1984, to ensure consistency and accuracy at the data collecting and reporting process.

The above review points out that although efforts were made to minimize serious violations of the underlying assumptions of a closed population model, there is reason to suspect that the population sizes will still be overestimated, depending on the severity of the violations of assumptions 1 and 2.

Estimation procedure and results

As an initial step in the estimation process, it was necessary to compile an appropriate set of statistics for vectors M, C, and R, in order to compensate for some sampling deficiencies, and ensure that the above conditions were met. For this purpose, the following adjustments were made to the census data available before estimating the population sizes.

Census data obtained prior to major pulses of immigration or emigration, were not incorporated into the estimation process, as these data were judged not to be representative of the marked ratio in the population under relatively steady state conditions. Such pulses were detected or confirmed by fence counts (immigration), the recovery of marked fish in other streams (emigration), and from the visual examination of the posterior distribution obtained after each iteration (both, but mainly immigration). Chi-square testing of census data was also conducted to test for changes in abundances, but these proved to be of limited use for this purpose, due to the small or unequal sample sizes available. Compensating for the effects of emigration and immigration resulted in the elimination of some earlier samples from the data set in some instances (Trent R. 1986, 1988), since both types of pulses occurred mainly during the early part of each season.

Census data from various sites obtained within a 48 h period were also combined to obtain a more representative estimate of the marked ratio in the population within that time period, by

minimizing the effects of the low or uneven sample sizes. Individual samples with less than 4 fish or 3 recoveries were combined with the sample taken during the nearest time period (< 4 d) in order to minimize to possibility of bias induced by small samples[11]. When combining equal size samples taken on different dates, the mean sampling date was usually considered as the actual sampling date.

Adjustments were also made to the values of M_t prior to estimating N, so as to reflect the actual number of marks available for sampling at certain locations. The value of M_t associated with each sampling event was set to the sum of the primary marks released up to the previous day for samples taken in the lower reaches, up to 2 d prior for samples taken in the middle sections, and up to 3 d prior for samples taken in the headwaters. This adjustment provided an allowance for the time required by marked coho to distribute themselves throughout the various sampling sites after being released at the fence. Adjustments were also made to the total number of marked coho present in the Trent River at various times to account for the departure of the marked coho recovered in other streams. All population estimates were derived from the adjusted data sets (Tables 5.2 to 5.4).

The suitable range of population sizes for the prior distribution was determined by inspection of the posterior distribution, and from a cursory examination of the mark proportions obtained during each season. For each age group, the lowest population size (N_{min}) was set at the minimum number of fish present in the stream (Table 4.8). The largest population level hypothesized (N_{max}) was initially set at 3 to 4 times the suspected level of abundance, and then reduced after each set of simulation so that the probability levels associated with N_{max} were negligible compared to that of the maximum likelihood estimate (N^c). For each simulation, 400 hypothetical population sizes (K) were evaluated within the final range selected.

Estimates of the sizes of the stream populations were generated for each age group/stream/year combination (Table 5.2 to 5.4). In most cases, the Bayesian estimates were found to be nearly identical to Pooled Petersen estimates generated from the same data, but the bounds associated with the Bayesian estimates tended to be slightly narrower than those associated with the Petersen estimates (data not provided).

The results obtained indicated that a substantial fraction of the total adult stream population was enumerated each year. This fraction ranged from 48 to 89% at Black Creek, 26 to 46% at Trent River, and 52 to 85% at French Creek. On average, a slightly smaller fraction of the jack population was enumerated each year, perhaps due to their lower catchability at the fence and during stream sampling. In addition, estimates of the jack population were characterized by considerable uncertainty due to the low marking and recovery rates. In some instances, the lack of sufficient number of surveys and/or recoveries did not allow for jack estimates to be generated (Trent River and French Creek, 1986).

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[11] As noted by Ricker (1978), in situations where M/N is small, the probability that the confidence intervals of R include 0 is less than 5% if the observed R≥3. Pooling samples can insure that this condition is met, and reduce the possibility of systematic bias.

5.2 ABUNDANCE ESTIMATES USING OPEN POPULATION MODEL

Description of open population model

The open population model constructed for this study was designed to make use of the mark-recapture data collected, as well as the observed upmigration pattern, the stream survey results, and additional information from field observations conducted in each system. The general approach was to simulate the mark-recapture process for each stream/year combination. As a first step, the build-up of the stream population and its subsequent decline are reconstructed. Based on the time series of abundance levels generated, the proportions of adults with marks expected to be found on given dates are determined. Discrepancies between the expected (i.e theoretical) and observed mark ratios obtained on successive occasions are then quantified. The hypothesized levels of abundance and stream life parameters were then estimated, by repeating this process several times with different estimates of undetected upmigrants, upmigration patterns, and survival rates.

The model was designed to keep track of 2 populations in the river; the total number of adults marked and released at the fence, and the total adult population comprising all enumerated adults released at the fence plus all adults that moved upstream undetected. The build-up of marked fish in the stream was obtained by summing up the number of marked fish released each day at the fence (corrected for any emigration losses reported). The same process was repeated for the enumerated fish, which were added to the undetected fish entering the stream on certain dates. All undetected fish were assumed to move upstream while the fence was partially or totally collapsed. If the fence was collapsed on only one occasion during that period, all undetected fish were moved upstream on that date. However, if the fence was collapsed several times during that period, the undetected fish were moved upstream on several dates.

The upmigration pattern selected for the undetected portion was one of two hypothetical patterns. In the first scenario, fish enter the stream in a decreasing fashion such that at least 50% of them move upstream during the first 2 floods, with decreasing proportions moving upstream during subsequent floods. This pattern best describes the usual upmigration pattern observed at French Creek and Black Creek under increasing flow conditions. In the second scenario, a fixed portion of the undetected population enters the river during each flood, such that the entire undetected population moved upstream by the end of the last flood. This pattern best describes the pattern observed at Trent River in years of low flow, when the upmigration began several days prior to the first period of high water. Simulations were conducted using both upmigration patterns for each case examined.

As soon as fish enter the stream, natural mortality was assumed to operate. As noted in section 5.2, estimates of the mean period of stream residency ranged from 9 to 13 d. Recoveries of marked fish released at the fence also indicated that adult cohos survived for as little as 1 d, to as much as 6 weeks. Such figures are comparable to those obtained by other investigators (see Willis 1954, Johnston *et al.* 1986, Crone and Bond 1976), which also reported positively skewed distributions of stream residency period. Therefore, in order to conform with the apparent non-symmetrical distribution of stream residency, the probability that fish would die on the x_{th} day was determined from the following log-normal probability density function;

$$f(x) = \frac{1}{x\sigma(2\pi)^{1/2}} \exp\left[\frac{-[\log(x/\phi)]^{1/2}}{2\sigma^2}\right] \quad (5.4)$$

in which ;

x = the number of d spent in fresh water after passing the fence
ϕ = median stream life
σ = standard deviation of log (x)

By using the following substitution, $W = e^{\sigma^2}$, then the shape parameters ϕ and σ are related to the more commonly used measures of central tendency ($\bar{x}$) and dispersion (s.d) as follows;

$$\text{Mean} = \phi \cdot \exp^{0.5\sigma^2}$$

$$\text{S.D} = \sqrt{\phi(W^2 - W)}$$

Realistic bounds for the shape parameters ϕ and σ where chosen for the simulations such that less that 1.5% of the fish entering the river on any given date would remain alive longer than 70 d. The values for ϕ ranged from 4 d to 34 d, which far exceeds the range of average stream residency estimates obtained during 1988 from the tagging studies (R. Bocking, pers. comm.). The maximum range of values used for σ was 0.1 to 1.0, but each ϕ value had an associated range of permissible σ's; this maximum range was used for low ϕ values (<6), the range was decreased progressively for intermediate ϕ values, and was lowest (0.1-0.36) for high ϕ values (>30).

A survival curve was produced for each combination of ϕ and σ, from the cumulative sum of the probabilities generated from Eq. 5.4 over a 90 d period. This curve was then used to reduce each daily pulse of upmigrants during their subsequent period of stream residency (90 d max.). Estimates of the total population, and the number of marked fish alive on each date, were obtained from the sum of the survivors from each pulse on that date. Expected mark ratios for each date were obtained from the ratio of both figures.

For each date on which stream surveys were conducted, the expected mark ratios were calculated and compared with the observed mark ratios obtained during stream surveys. For comparative purposes, stream survey data from Tables 4.4 to 4.6 were used instead of data from Tables 5.2 to 5.5, since the census data obtained prior to the upmigration period can be utilized by the model. Since the model does not use mark ratios based on live and dead recoveries for comparative purposes, it was necessary to adjust the stream survey samples so as to exclude all carcasses sampled.

As a measure of the goodness-of-fit between expected and observed mark proportions, the binomial probability model was used instead of the traditional Chi-square test. Since the stream survey samples are independent of each other, the probability of observing all the R's given some hypothetical population size and associated parameters is given by;

$$(5.5) \qquad P(R_1,R_2,..R_t|N_i,M,\phi_j,\sigma_k) = \prod_{t=1}^{T} \binom{C_t}{R_t} \left(\frac{m_t}{n_{i,t}}\right)^{R_t} \left(1-\frac{m_t}{n_{i,t}}\right)^{C_t-R_t}$$

in which;

N_i = Hypothesized number of adult coho that entered the stream (i levels)
$n_{i,t}$ = Number of fish from N_i remaining in the stream at time t
M = Total number of marked fish released at the fence
m_t = Number of marked fish from M remaining in the stream at time t
ϕ_j = Median stream life selected within permissible range (j = 4 - 34)
σ_k = Standard error selected within permissible range (k = 0.1 - max)
C_t = Number of fish examined during stream survey at time t
R_t = Number of fish with primary marks recovered during stream survey at time t

The above equation allows for the computation of probability levels for each combination of N, ϕ and σ which characterize a hypothetical population (H_n). Probability levels associated with each hypothetical combinations of population attributes were found by iterating over the range of population sizes and parameter combinations. During a typical simulation trial, 30 increments in population sizes were tested between the lowest and highest abundance levels hypothesized. For each population size tested, ϕ was increased by 1 unit from 4 to 32, and for each ϕ value, σ was increased by at least 0.025 units, from 0.1 to the maximum allowable value.

For each simulation, one combination of population size and stream life parameter (H') provided the best fit (highest probability) to the observed mark ratios. However, numerous other combinations generated fitted the data almost equally well, and were considered as alternative hypotheses (H_n). The suitability of each alternative hypothesis was determined by reference to the likelihood ratio, $L(H',H_n \mid R)$, and the Method of Support (Edwards 1984). Alternative hypotheses were not considered plausible if the natural logarithm of their likelihood ratio exceeded 2 units [12]. From the remaining subset of acceptable hypotheses, the likelihood of a given population size (N_i) was obtained by the following equation;

$$(5.6) \qquad L(N_i) = \frac{\sum_j \sum_k P(R|N_i,M,\phi_j,\sigma_k)}{\sum_i \sum_j \sum_k P(R|N_i,M,\phi_j,\sigma_k)}$$

Based on the likelihood of each hypothesized abundance level, the marginal distribution of N was generated, which serves to identify the maximum likelihood estimate of abundance (N^o, for Open population model), as well as the upper and lower bounds (95% credibility regions).

Model assumptions

This model still requires the population to be closed geographically, but immigration and death can occur. However, emigration is assumed to be non-existent. In cases where some emigration is known to occur, adjustments are made to account for it based on the number of emigrants reported. In the present context, it is doubtful that all emigrants from the Trent River

[12] This procedure is analogous to the rejection method based on a 2 standard deviation spread in parametric testing (Edwards 1984).

were recovered. Additional undetected emigration of marked fish would cause the population to be overestimated just as with the previous model.

Given that this model also utilizes census data for testing hypotheses, assumptions #2, 3, 5, and 6, listed previously, concerning the marking and subsequent sampling, must also be satisfied. Several additional assumptions concerning the distribution and survival rate of marked and unmarked fish must be met, and are described here.

For each season, jacks and adults were considered as distinct populations, and were estimated separately. Except for this age group distinction, the model does not account for particular behavioral attributes that could be exhibited by distinct segments of the run. Marked and unmarked coho, as well as early and late migrants, were assumed to be distributed uniformly throughout each stream. In all simulations, members of both age groups were assumed to be distributed throughout the lower section of the stream within 24 h after passing the fence, with 48 h and 72 h required to reach the middle and upper reaches.

Marked and unmarked coho, as well as members of each sex, were assumed to have similar rates of natural mortality during their period of stream residency. Coho marked with external Petersen disks were also assumed to have the same mortality rates as the those marked with opercular or tail punches. Coho entering the stream at different times are assumed to have the same period of stream residency. For some cases, the validity of this last assumption is questionable, since late migrants captured at the fence in an advanced maturation stage may have a shorter residency period than relatively immature silver adults. In the absence of adequate empirical data to quantify this factor, there was no justification is assuming that various segments of the run had significantly different die-off patterns.

As noted in section 4.3, a substantial portion of the jacks present swam through the fence panels. Daily fence counts were expanded according to field observations at each site to account for the jacks escaping undetected while the fences were operational. The remaining undetected jacks were assumed to move upstream during periods of floods as described previously.

In addition to the above assumptions, a few criteria were used to judge the acceptability of alternative hypothesis prior to generating the marginal distributions. These criteria were formulated on the basis of field survey results and additional observations made during the estimation process. The following criteria were used in all cases;

Limits were imposed on the size of the population allowed to remain in the stream by the end of the season. For a hypothesis to be acceptable, the number of live fish remaining in the stream by December 30 had to be less than 5% of the Bayesian estimate of population size (N^c). This had the effect of eliminating some unrealistically large or small populations with odd parameter combinations, which occasionally provided an acceptable fit to the data, but had too few or too many fish left in the river at the end of the season to be considered as reasonable alternatives.

The simulation results were strongly influenced by the upmigration pattern of the undetected portion. For the majority of cases, simulations based on the decreasing upmigration pattern provided a better fit than those based on the uniform upmigration pattern. Regardless of the upmigration pattern used, it is necessary to select an appropriate time limit beyond which no substantial upmigration of undetected fish occurred. Based on field observations, it was assumed that the upmigration generally ended during the first week of December. In some instances, the periodicity of floods, or examination of the fence count records, dictated that slightly shorter or longer time limits be selected.

Additional data obtained during the instream indexing surveys conducted in these systems since 1986 (Johnson *et al.* 1987, Bocking *et al.* 1988, and Bocking, pers. comm.) were also used to validate the estimates obtained. Theoretically, both the mean residency period, and the indices of abundance obtained from those surveys, could be used to filter out alternative hypotheses which do not comply with the empirical results obtained. For the present purposes, it was assumed that the indices of abundance (if available) were representative of the size of the stream population at specific times during the spawning period. The ratios of the live counts obtained on successive dates by the surveyors were calculated. Then, all parameter combinations which predicted changes in abundances levels exceeding the calculated ratios by ± 15% were rejected. This procedure generally did not substantially alter the maximum likelihood estimate of population size, but did filter out some hypotheses with incompatible stream life parameters, which effectively reduced the range of stream residency parameters remaining.

Estimation results

An examination of the best fitting values obtained for each case revealed little intra-stock or inter-stock similarity in stream residency parameters during 1985-1988 period (Table 5.5). No strong relationship was found between the point estimates of ϕ and σ across all years for any given population. There was a tendency for the median period of stream residency of the adult populations at French Creek and Trent River to follow a similar trend over the years. It should be emphasized that the stream residency parameters estimated by this method are characterized by a substantial amount of uncertainty. In several cases, the range of mean residency values associated with the alternative hypotheses was very broad (4 - 35 d). In cases where additional data from snorkel surveys and index counts were used in the estimation process (Population size limits, Table 5.5), the range of stream residency values was usually narrower. It should be noted that all the ranges overlapped with the 18 - 26 d interval, which supports the notion that the mean period of stream residency for these populations is in the order of 3 weeks. No evidence was found to indicate that the period of stream residency was consistently greater at one location that at the other, or consistently greater among jacks or adults in a given population.

The range of the estimates of mean residency period for each case occasionally overlapped, and usually exceeded the estimates of average stream residency obtained by means of spaghetti tags during 1988 (9 - 13 d), but were comparable to some estimates obtained by means of opercular punches at the Little Qualicum spawning channel during 1987 (15 to 28 d, unpublished data). The possibility exists that the figures obtained by means of external tags underestimated the average stream life owing to the physical effects of spaghetti tags, and the uncertainty associated with the estimation process based on a depletion curves (see Bocking *et al.* 1988). Alternatively, both the point estimates, as well as the range of means obtained from the simulations may not accurately reflect the true patterns. The range could be narrowed considerably, and the point estimates improved if accurate empirical estimates of the variation in stream residency were available. In the absence of any additional information to account for the discrepancies between various estimates of stream residency, and justify the use of a particular range of values, the likelihood of stream population sizes was inferred simply on the basis of the marginal distributions generated.

The best estimate of the stream population given by the marginal distribution (N^o) was similar to its corresponding point estimates (N'), with the maximum discrepancy between both values ranging from +26% to -20% of N'. Differences between both estimates are attributed to the fact that the level of abundance associated with the best fitting parameter combination is not always the most frequent alternative, in part due to the level of resolution and the size of the increments used in the model. Differences of such magnitude, coupled with the lack of consistent differences between both values were considered as normal .

The lower and upper bounds associated with each estimate of N^o were usually narrower than the corresponding bounds of N^c (Fig. 5.1). As anticipated, $N^c > N^o$ in the majority of cases. The difference ranged from as little as 2%, to as much as 45%. The differences between the adult estimates were smallest at Black Creek, presumably due to the fact that marking was always conducted throughout a greater portion of the run than elsewhere, and violations of assumptions 1 and 2 were less severe than elsewhere. Differences were substantially larger and less consistent at Trent River, where fence operations were characterized by floods and disproportionate marking regimes. The uncertainty associated with the extent of the emigration each year on this stream also contributed to the difficulty of generating precise estimates of population size by either method.

With regards to the jack populations, estimates of abundance could not be generated in several cases owing to the lack of sufficient number of recoveries, and had to be generated by some alternative method (Section 5.3).

In the absence of full fence counts, it was impossible to determine with certainty which model provided the more accurate estimates of abundance. Given the fact that the Bayesian estimates were almost identical to pooled Petersen estimates (see previous section), and that Petersen models are known for their tendency to overestimate coho escapement levels (Simpson 1984), it was assumed that the Bayesian estimates exceeded the true abundance of jacks and adults. Furthermore, since the populations under study were never 'closed' during the marking and sampling period, estimates of jack and adult population sizes obtained from the recursive estimation procedure were considered to be more reliable on theoretical grounds, and were relied upon for subsequent analysis.

5.3 JACK ABUNDANCE ESTIMATES FROM JACK/ADULT RATIOS

In order to determine the level of jack abundance in cases where an insufficient number of recoveries was available to use the previous models, estimates were generated by reference to the jack-to-adult ratio in the stream. The relative abundance of jacks in each stream was first estimated as follows;

$$\%\,\text{Jacks} = \left(\frac{\sum C_{\text{jacks, fence}} + \sum C_{\text{un. jacks, stream}}}{\sum C_{\text{adults, fence}} + \sum C_{\text{un. adults, stream}}} \right) \tag{5.7}$$

in which;

$C_{jacks,fence}$ = Daily count of jacks released the fence adjusted for emigration losses
$C_{un.jacks,stream}$ = Count of unmarked jacks (or adults) captured during each stream survey
% Jacks = Relative abundance of jacks expressed as a fraction of the adult pop.

Assuming that the ratio conforms to the binomial distribution, then the probability function of the ratio can be generated (F(x)), and combined with the likelihood curve of adult abundance given by the marginal distribution (G(y)), to produce a binomially weighted likelihood curve of jack abundance (Q(z)). This can be expressed as follows;

(5.8) $$Q(z) = \sum \left[F(x)\Delta x \sum G(y)\Delta y \right]$$

From the curve generated, the maximum likelihood estimate of jack abundance is obtained, and its associated lower and upper bounds. Reliable estimates of jack abundance can be obtained by this method if jacks and adults are equally susceptible to capture during the sampling process. Given the apparent lower detectability of jacks at the fence, and their lower catchability during stream surveys, the estimates generated by this model are expected to be negatively biased. Accordingly, a comparison of the figures in Tables 5.5 and 5.6 reveals that the estimates generated by Eq. 5.8 were always lower than their corresponding mark-recapture estimate. In addition, estimates of the minimum number of jacks in the stream (Table 4.8) occasionally exceeded the estimated lower bound. Therefore, the estimates obtained by this method were only relied upon in the absence of alternative estimates of population size (Trent River 1986, 1987, and French Creek 1986). For such cases, no attempt was made at correcting the estimates to account for potential bias, given the lack of information on the magnitude of the potential differences in detectability.

5.4 ESCAPEMENT LEVELS AND SPAWNER ABUNDANCE

Total escapement levels were determined for each age group by adding the number of fish collected at the fence, to the estimated stream populations, and their corresponding lower and upper bounds. Spawning population estimates were obtained by deducting the total number of fish collected in the stream from the estimated stream population, and the corresponding lower and upper bounds (Table 5.7). Figures obtained by this method may be slightly biased in some instances since the exact number adults collected in each stream by club members is not always known. No attempt was made to estimate the number of fish that died before spawning, but field observations suggested that at least 5% of the females died before spawning due to predation, injuries and physiological disorder.

Crude estimates of the escapement levels to each stream during 1984 were made on the basis of the relative abundance of fish on the spawning grounds as observed during the stream surveys. At Black Creek and French Creek, adult densities at all sites sampled during the spawning season appeared to be similar to those observed in 1985, and definitely greater than those observed in subsequent years. At Trent River, adult coho densities in 1984 appeared to be slightly less than those observed in 1985 and 1986. Thus, the 1984 escapement levels to each stream were estimated to be similar to the 1985 levels. Jack abundance in each stream during 1984 was also estimated to be similar to the 1985 levels.

A cursory examination of the figures presented reveals some trends in adult escapement patterns from year to year. During the course of this investigation, escapement levels at Black Creek and French Creek showed a pronounced drop during 1987, followed by a partial recovery in 1988. By contrast, escapement levels to the Trent River remained fairly stable during the 1985-1988 period. In order to determine the significance of the trends observed, information on the stock composition of each run should be examined (Section 6.1).

6.0 VARIATION IN RUN SIZE AND STOCK COMPOSITION

6.1 CWT CONTRIBUTION AND SPAWNING STOCK COMPOSITION

Coded wire tag identities provided by the Head Recovery Program (SEP), and associated data on the age and external marking of each fish sampled were tabulated by recovery location and recovery year (Tables 6.1 to 6.3). Information on the numbers and features of coho sampled lacking a tag (No pin) was also included. The number of heads submitted lacking a tag was quite variable, ranging from 0% to 66% of the heads submitted by age group/stream/season combination. The absence of a tag can be attributed to the removal of a head when the adipose fin condition was questionable, or the removal of a head from a fish which naturally lacked an adipose. In addition, missing tags can also be due to tag rejection which is usually detected to a greater or lesser extent following implantation. For the present purposes, the first two factors are considered to be sampling errors, while the later factor is considered as tag loss. During the present study, no tests were conducted to determine the magnitude of the effects of sampling error versus tag loss upon the number of "No pin" obtained, but the effects of both factors were considered to be approximately equal. Whenever possible, the nature of the factor responsible for the absence of the tags was inferred based of the condition of the fish (age group, missing fins), previous tagging operations, and the identity of the remaining tags submitted in each case.

Black Creek

At Black Creek, examination of the tag code identities revealed that all tags recovered during the 1985 to 1988 period had been applied at Black Creek. Given the absence of fish lacking a ventral fin (of hatchery origin), and of tags applied at neighboring hatcheries, there was no evidence to indicate that coho from neighboring streams strayed to Black Creek during the period of study. Since no tags were applied in 1984 in this stream, the single head recovered in 1985 without a tag was assumed to result from a sampling error. No tagged jacks were sampled in 1986 for CWT identification. In the absence of evidence of straying to this stream, all tagged jacks that escaped in 1986 were assumed to be of Black Creek origin. All remaining adults and jacks lacking a tag were assumed to have lost their tag. In most cases where tag loss was hypothesized to occur, the number of tags recovered for each code in a given age group was adjusted to compensate for tag loss, in relation to the contribution of each code to the sum total of all identified tags. These adjusted recoveries were calculated as follows;

$$T_{adj,c} = T_{obs,c} + Np\left(\frac{T_{obs,c}}{\sum_{C} T_{obs,c}}\right) \qquad (6.1)$$

in which;

$T_{adj,c}$ = Adjusted recoveries of tags with code c
$T_{obs,c}$ = Observed recoveries of tags with code c
Np = Number of heads recovered without tags (No pin)

The contribution of each code to the total recoveries for a given age group was then calculated as follows;

(6.2) $$\%T_{adj,c} = \frac{T_{adj,c}}{\sum_{C} T_{adj,c}}$$

The total number of tags of each code in the escapement was estimated from;

(6.3) $$T_{tot,c} = \%T_{adj,c} \cdot P_{ad} \cdot Esc$$

in which;

$T_{tot,c}$ = Total number of tags of code c in the escapement
P_{ad} = Proportion of the total escapement lacking an adipose fin (Table 4.8)
Esc = Escapement of a given age group to the stream (Table 5.7)

All tagged adults identified had an ocean residency period of approximately 18 months. Thus, no evidence was obtained to indicate that the Black Creek escapement contained adults of age 4_1 or 5_2.

Trent River

At Trent River, tag code identification indicated that a substantial number of tagged jacks and adults recovered each season were not of Trent River origin. In fact, all strays recovered were of hatchery origin, and released from facilities as far away as 150 km from the Trent River. On an overall basis, the majority of strays were from the Puntledge River hatchery, which is the closest of all contributing hatcheries to the river.

Given that no tagging was conducted at this location in 1984, and that all adult heads recovered in 1986 lacking tags were fin clipped ("Expo fish" of hatchery origin), all adult heads recovered during 1985 and 1986 lacking a tag were assumed to be hatchery coho with lost tags. All 1985 adult recoveries associated with hatchery releases were adjusted according to Eq. 6.1, once the Trent River recoveries were excluded from $\sum T_{obs,c}$. All heads recovered without tags in 1986 were associated with Puntledge tag codes 022946 or 022915, since these were the only 2 groups released from this hatchery in which all tagged fish were fin clipped (i.e ADLV clip). All adult recoveries for 1987-1988 were adjusted according to Eq. 6.1 without modifications, since no evidence was available to indicate that the heads lacking a tag were predominantly strays.

In order to estimate the contribution of hatchery fish to the total escapement each year, the number of recoveries associated with the hatchery recoveries were expanded to account for the untagged portion of each release associated with a specific code. Tagged proportions associated with each release was obtained from the MRP database records. The total number of strays associated with a given tag code that escaped to the Trent River was estimated as follows;

(6.4) $$Strays_c = \frac{T_{exp,c}}{\%\ Rel_c}$$

in which;

$Strays_c$ = Total number of strays that escaped associated with code c
$\%\ Rel_c$ = Fraction of the hatchery release in lot c that were tagged

No corrections were made to account for the pre-release tag loss reported in the MRP database since the tag recoveries were already adjusted for tag loss at return. No attempt was made to account for unassociated[13] releases from the contributing hatcheries given the uncertainty involved in the association process. The stock composition for each season was then determined on the basis of the relative contribution of the strays from each hatchery to the total run. The proportion of the total escapement contributed by each hatchery stock was determined as follows;

$$\%\,\text{Hatchery}_{\,i} = \frac{\sum \text{Strays}_{\text{all c's of i}}}{\text{Total Escapement}} \qquad (6.5)$$

The number of adults remaining after accounting for the total hatchery contribution was assumed to represent the total escapement of adults of Trent River origin. The results obtained revealed that adults of hatchery origin contribute significantly to the Trent River escapement each year (Table 6.3). The estimated contribution was substantial in 1985 (17%), highest in 1986 and 1987 (48%, 50%), and lowest in 1988 (5%). Information on the relative abundance of fin clipped adults observed in 1986 was used to assess the reliability of the contribution estimates obtained by expansion of tag code recoveries. The proportion of fin clipped adults in the 1986 escapement was previously estimated to be 40.1% (Table 4.8). Given that about 82% of the smolts released for Expo at the Puntledge hatchery were fin clipped, the proportion of fin clipped adults in the Trent River was expanded by 1.22 to account for the unclipped smolts released, which resulted in an estimated contribution of hatchery adults to the 1986 adult escapement of about 49%. This figure is almost identical to the estimate based on the expansion of tag recoveries, which suggests that the estimates of hatchery contribution based on tag recoveries can be reliable.

It should be noted that estimates of the stray component obtained by either method are minimum estimates of the contribution of strays to the Trent River. Coho from large neighboring streams such as the Tsable River may also be present in the Trent River, but cannot be accounted for in the absence of tags or particular marks.

All tagged adults identified had an ocean residency period of approximately 18 months. Thus, no evidence was obtained to indicate that the Trent River escapement contained adults of age 4_1 or 5_2.

The 1985 and 1988 tag escapement for jacks, and associated contributions were estimated by the same method. Insufficient number of recoveries in 1986 and 1987 did not allow for the above procedure to be used. Only one of the three jack heads submitted in 1986 was identified, and was determined to be a stray from the Quinsam hatchery. Adjusting and expanding that recovery according to the above equations resulted in an escapement estimate for Quinsam strays exceeding the total jack escapement to the river. It is doubtful that 100% of the tagged jacks escaping to the Trent River in 1986 were of Quinsam origin. Some of the tagged jacks should be of Trent River origin given that a substantial fraction of the 1986 smolt output at the Trent River was tagged. In view of such facts, both heads lacking a tag were assumed to be Trent River jacks with lost tags. It was assumed that the tagged proportions among jacks of Trent River origin was identical to that observed adults of Trent River origin in 1987 (36%), which resulted in an escapement of 14 jacks of Trent River origin. This left 29 jacks of hatchery origin in the escapement, which is less than the estimate of 42 obtained by direct expansion of the hatchery tag recoveries.

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[13] A group of fry or smolts released from the hatchery or transplanted to a neighboring stream, which does not contain coded wire tagged individuals, and which is not associated with another tagged group.

During 1987, no jacks with tags were collected for CWT recovery. In view of the absence of evidence to indicate that the tagged jacks in the escapement were strays, and the relatively low stray rates observed in the 1988 adult escapement, all tagged jacks that escaped in 1987 were assumed to be of Trent River origin.

French Creek

Although no juvenile tagging was conducted in this stream during 1985, all adults captured in 1985 and 1986 were examined for missing adipose, but none were detected (Table 6.4). All tags recovered from adults during 1987 and 1988 were of French Creek origin. This indicates that the contribution of hatchery strays to the adult escapement at French Creek was negligible. Such results are substantiated by the fact that the relative abundance of fin clipped adults ("Expo fish") in the 1986 escapement was small (< 0.8%, Table 4.3). Thus, there is no evidence to indicate that substantial numbers of adult coho from neighboring streams and hatcheries strayed to French Creek during the 1985 to 1988 period. The same conclusion applies to jacks, given the absence of recoveries of tags from other streams. It should be noted that estimates of the stray component translate into minimum estimates of the contribution of strays to French Creek. Coho from adjacent natural streams such as the Englishman River may also stray to French Creek, but cannot be accounted for in the absence of tags or particular marks.

All adults and jacks lacking a tag were assumed to have lost their tags. Total tag escapement by code was estimated following adjustments and expansion according to Eq. 6.1 to 6.3. All tagged adults identified had an ocean residency period of approximately 18 months. Thus, no evidence was obtained to indicate that the French Creek escapement contained adults of age 4_1 or 5_2.

6.2 SEASONAL AND STOCK VARIATION IN ADULT SIZES

Samples of length measurements taken at the fence and during stream surveys were combined to provide a better description of the inter-stock and seasonal variability in adult size. The average size of females was usually greater than males in a given stream (Table 6.5). On average, the length of females exceeded that of males by 4.2% at Black Creek, 5% at Trent River, and 4.3% at French Creek, but significant differences between male and female lengths were detected in less than half the cases (Mann-Whitney test, Table 6.5).

Length measurements for both sexes were pooled to provide an estimate of the mean size for each adult population. On average, Black Creek adults were approximately 5.2% larger than Trent River adults, and 8% larger than French Creek adults. Variation in mean length were also apparent between seasons. The mean length of adults in each stream showed a tendency to increase from 1984 to 1985, and then decrease progressively thereafter until 1988 (Fig. 6.1). Multiple range tests revealed significant differences in mean adult size between years in all streams. Adult sizes for each season and each stream were log transformed and submitted to a two-way ANOVA, with stock and season as factors. Both factors were observed to have significant effects upon the mean adult size ($p = 0.001$ for stock, season, and interaction effects).

Seasonal changes in mean length were also apparent among jacks from each stream. The means did not follow the same trends as were observed for adults (Fig. 6.2). Black Creek jacks were usually larger those of French Creek and Trent River, but the magnitude of the difference varied considerably from year to year. Regressions of mean jack length on mean smolt length revealed no significant relationship for Black Creek smolts, and only a weak relationship for Trent

River (r^2= .67) and French Creek (r^2= .46). Due to the lack of sufficient sample sizes, no further statistical comparisons were conducted to determine the factors affecting the variability in mean jack length. However, the mean jack length in different stocks did not appear to exhibit any similarity in seasonal trends.

6.3 TEMPORAL CHANGES IN STOCK COMPOSITION

The results obtained during this investigation revealed large differences between the spawning populations of each stream in terms of their stray component. The lack of significant numbers of hatchery strays in the escapement observed at Black Creek and French Creek during this study indicates that the level of inter-breeding with hatchery fish from neighboring facilities is not substantial, and that these spawning populations are maintaining some integrity despite large scale hatchery production in the region. By contrast, the extent of the contribution hatchery fish to the Trent River escapement, coupled with the apparent hybridization observed, suggests that there can be considerable year to year variability in the stock composition of that spawning population.

The simple fact that the Trent River differs markedly from the other two streams in terms of its attractiveness to strays from several Georgia Strait hatcheries is puzzling. Presumably, the proximity of the Trent River to the Puntledge hatchery is partly responsible for the large number of Puntledge River strays found in the Trent River. However, the geographical location of the Trent River does not intuitively explain the presence of strays from the more distant hatcheries. By comparison to Black Creek and French Creek, the Trent River has a greater and more continuous discharge, and a larger estuary. Such facts suggests that strays may be attracted more readily to larger rivers, than small streams. This hypothesis is further supported by the fact that relatively large number of hatchery strays were also found during 1986 in the Tsable River (30% of the fish examined), which is physically similar to the Trent River, and located on the same coast approximately 10 km south of this system.

The large emigration of adults from the Trent River in 1986, coupled with their return to the Puntledge hatchery suggests that many of the strays entering the Trent River are simply exhibiting "proving" behavior (Ricker 1972), and may not be committed to spawning there. Wether or not the number of adults that prove a stream in a given year is related to a particular attribute of the stream is not known. No such coho were ever detected at French Creek and Black Creek, although they are both located in the proximity of large hatcheries. This may suggest that these small streams have a more characteristic odor, which allows the fish to distinguish them more easily than the Trent River. Alternatively, the location of the fence at Trent River (in intertidal waters) may have been responsible for the large number of proving fish detected, and perhaps fewer proving fish would have been detected if the fence had been positioned further upstream. Further investigations are required to confirm this hypothesis.

Part of the year to year variation in the contribution of hatchery fish to the Trent River escapement can be attributed to changes in the tagging and production regimes both at the hatcheries and in the Trent River, as well as variation in straying rates as induced by biological and physical factors. It should be noted that the relative abundance of strays among the adult population was highest in 1986 and 1987 when a prolonged drought period affected the upmigration on all streams in the region. Based on this observation, it could be hypothesized that the magnitude of straying is to some extent affected by the environmental conditions. Insufficient flows may inhibit the ability of maturing coho to properly home in on their stream of origin, or may induce mature coho to seek alternative refuges and spawning locations. Additional investigations are currently being conducted by the author to quantify the magnitude of straying

among hatchery and non-hatchery stocks in the region, and the factors accounting for the patterns observed.

Even in the absence of substantial straying, external factors may also affect the biological traits of these populations. Brood stock collection as conducted at French Creek and Trent River can potentially disrupt natural processes, such as the natural selection for mates, the sex and jack-to-adult ratios in the spawning population, and the stock composition of the remaining spawners. Outplanting fry on a sustained basis can also potentially alter the genetic make-up of the population in the long run. Unfortunately, the impact of local enhancement activities upon the characteristic features of the these populations could not be quantified based on the information obtained during this study.

7.0 DISCUSSION

One of the major contributions of this investigation, has been to provide information on the current status of each coho population, and some insight into the seasonal and inter-stock variability in smolt output, escapement levels, and juvenile and adult compositions of these streams. The magnitude of the variability observed, coupled with the lack of sufficient data to quantify the effects of various factors involved, emphasizes the need for the continued monitoring of these populations. Should sufficient resources be made available for this purpose, it might prove fruitful to modify some of the local enhancement activities and sampling procedures, in order to reduce the uncertainty associated with the estimates generated, and ensure that the effects of environmental and biological factors can be determined.

Previous studies have reported that stocking streams with hatchery presmolts failed to rehabilitate wild coho populations (Nickelson *et al*. 1986). The results of this study do not support or contradict such conclusions, since such impacts cannot be quantified. Marking a large fraction (>50%) of all outplanted groups in the future would definitely allow for improved assessments. The information obtained from their recapture would reduce the uncertainty concerning the relative outmigration patterns and survival rates of both 'types' of smolts, the natural smolt output per spawner, the carrying capacity of the stream, the impact of fry releases upon the natural component of each stream, as well as update the various estimates contained in the present report. In addition, data on the relative abundance of marked adults in the escapement would provide information on the marine survival rates of outplanted and natural fry, and more reliable estimates of the relative abundance of strays in the escapement. Knowledge of the success of the local enhancement procedures would also serve to improve the procedures used, and assist in determining the level of effort invested into fry rearing and habitat improvement.

Even if all outplanted fry released were marked, the juvenile trapping method used does not usually provide estimates of the total smolt output of each stream. The results obtained indicate that the number of undetected smolts far exceeds the observed output, and even the adjusted estimates based on field observations. Should this prove to be true, then a substantial portion of the smolt population leaves each stream outside the main outmigration pulse observed each year. In future trapping operations, the traps used should be modified in order to maintain trapping operations under low water conditions, and efforts should be made to conduct trapping and tagging throughout the remaining summer months. This would help determine the magnitude of the remaining outmigration, the relative survival rate and fishery contribution of late migrants, and provide more reliable estimates of stray contribution to the escapement.

With regards to the escapement estimation process, the collapsible fence design used for this study proved to be more reliable than anticipated. Still, the frequency and magnitude of the floods encountered at Trent River, coupled with the manpower requirements for handling the heavy debris build-ups at French Creek and Trent River highlights the need for further improvements. Ideally, a complete or partial enumeration should be conducted during floods, so as to reduce the dependency upon mark-recapture estimates. Electric barriers (Burrows 1957) such as the type used at Rosewall Creek, or sonic devices such as those tested by Johnson *et al.* (1986), could be used singly, or in conjunction with a collapsible fence, to monitor adult migration patterns during floods, and improve the reliability of escapement estimates.

Should reliance upon mark-recapture methods be necessary, the results of this study show the need to conduct some surveys in neighboring streams to determine if emigration of marked fish is occurring. Even in the absence of emigration, the results obtained indicate that coho escapement estimates generated from closed population models are likely to be positively biased to some extent, particularly if marking is not conducted proportionally throughout the run. The recursive estimation procedure proposed may provide more accurate estimates under such conditions. However, appropirate empirical tests must still be conducted to determine how the estimates obtained from the procedure suggested compare to those of other open population models, in terms of accuracy, precision, and sensitivity to violations of the underlying assumptions.

The use of conventionel open population models usually require an estimate of the mean and variance of stream life for adults and jacks, or an alternative estimate of mortality rates. Results obtained from additional simulations (not presented here) have shown that the stream life parameters used during the simulations have a profound influence upon the estimates generated, and particularly in situations when stream surveys cannot be conducted in sufficient numbers, and at regular intervals throughout the spawning period. Ironically, it is exactly under this type of condition that stream life is most difficult to estimate, since the die-off pattern cannot be determined with certainty by field surveys. This problem is further compounded by the fact that preliminary results from indexing studies conducted in these streams (Johnston *et al.* 1987, Bocking *et al.* 1988, R. Bocking, pers. comm.) suggests that stream life may vary considerably between streams in a given year. This may prevent investigators from using stream life parameters from neighboring populations, to estimate the abundance of a given population where stream life could not be estimated. Under such conditions, abundance levels could always be estimated by the method proposed in this report.

Irrespective of the mark-recapture model selected, reliable estimates can usually be generated if a large proportion of the run is marked and recovered. Since the number of fish recovered during stream surveys is affected by the hydrological conditions, efforts should be made to mark as many fish as possible at the fence to compensate for potentially low recovery rates. Collecting fish from the Trent River and French Creek fences to supply the local hatcheries with brood stock can cause a considerable reduction in the number of marked fish released, mainly because these fences do not always intercept a large portion of the escapement. Collecting broodstock from the headwaters would allow a greater number of marked fish to be released into each stream, and would serve to increase the level of stream sampling effort. As a result, the mark-recapture estimates obtained would be improved considerably. In addition, collecting brood stock from the headwaters at Trent River would reduce the possibility of collecting hatchery strays, and ensure that the fry released subsequently are mostly of Trent River origin.

The potentially large number of strays distributed throughout the lower reaches of the Trent River also creates some sampling difficulties for CWT recovery. If a large proportion of the heads recovered are obtained from the fence area early in the season, then the stock composition estimates may reflect the stock composition in the lower reaches, where hatchery strays are relatively abundant. Further expansion of the tag codes from this sample could overestimate of the stray

component, and provide biased estimates of the tagged proportions among coho of Trent River origin. Ideally, the stock composition estimates obtained should reflect the composition among the entire spawning population. In order to ensure this, attempts should be made to collect heads during the stream surveys, and not rely heavily upon the samples collected below the fence with beach seines.

Information presented in the previous sections has shown that the detection of a single hatchery tag in the samples can indicate that many hatchery fish are present, particularly when only a small portion of the total number of hatchery fry released are tagged. Thus, efforts should be made to maximize the number of heads collected in as many areas as possible throughout the season. During this study, the number of heads recovered during the stream surveys was often insufficient for determining the stock composition. Given that tagged carcasses and spent coho are easily removed by predator, and flushed out of the stream during floods, it might be necessary during future surveys to collect some adults prior to the spawning period, to ensure that sufficient sample sizes are obtained.

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TABLES

Table 2.1. Fry releases at Black Creek, 1985-86. Figures provided by R.E. Hurst, Special Projects Division, SEP/DFO.

Release date	Release site	Species released	Brood stock	Fry released	Fry Size (g)	Mark used
Jul. 85	Cranberry	coho	Black Cr.	10249	1.7	R. ventral
Jul. 85	mainstem	coho	Black Cr.	10600	1.7	none
Jul. 86	headwaters	coho	Black Cr.	16500	4.5	R. ventral
Aug. 86	headwaters	coho	Black Cr.	6998	3.0	L. ventral
Aug. 86	headwaters	coho	Black Cr.	25284	2.6	none

Table 2.2. Fry releases at Trent River, 1985-87. Figures provided by R. E. Hurst, Special Projects Division, SEP/DFO. [*] Approximately 7.4% of the total release (or 4636 fry) were recaptured in the field as 1.5 g fry and fin clipped. Additional details are given in Hurst and Blackman (1988).

Release date	Release site	Species released	Brood stock	Fry released	Fry Size (g)	Mark used
May. 81	Bloedel Cr.	coho	Puntledge	80000	<1.0	none
May. 82	Bloedel Cr.	coho	Puntledge	65000	<1.0	none
May. 83	Bloedel Cr.	coho	Puntledge	90000	<1.0	none
Jun. 83	headwaters	coho	Puntledge	90000	<1.0	none
Jul. 83	mainstem	coho	Puntledge	149000	5.6	none
May. 84	Bloedel Cr.	coho	Big Qual.	100000	<1.0	none
Jun. 84	headwaters	coho	Big Qual.	80000	1.2	none
Jun. 85	Bloedel Cr.	coho	Trent	45000	2	none
Jun. 85	Bradley L.	coho	Trent	18185	2.4	L. ventral
Jul. 85	headwaters	coho	Trent	7500	2.4	R. ventral
May 86	Bloedel Cr.	coho	Trent	62645	0.8	R. ventral *
Jun. 86	Bradley L.	coho	Trent	34461	1.5	L. ventral
Jun. 87	China Cr.	coho	Trent	5300	2.3	none
Jun. 87	China Cr.	coho	Trent	5300	2.3	none
Jun. 87	headwaters	coho	Trent	5400	2.3	none
Jun. 87	Bradley L.	coho	Trent	30000	2.5	none
Jun. 87	Bloedel Cr.	coho	Trent	30000	2.5	none
Jun. 88	Bradley L.	coho	Trent	18000	3.5	L. ventral
Jun. 88	Bloedel Cr.	coho	Trent	18000	3.5	R. ventral
Jun. 88	headwaters	coho	Trent	7000	3.5	R. maxillary
Jun. 88	China Cr.	coho	Trent	7000	3.5	L. maxillary

Table 2.3. Fry releases at French Creek, 1985-88. Figures provided by R.E. Hurst, Special Projects Division, SEP/DFO. Additional details are given in Hurst and Blackman (1988).

Release date	Release location	Species released	Brood stock	Fry released	Fry Size (g)	Missing fins
Jun. 85	mainstem	coho	French Cr.	20000	1.5	none
Sep. 85	Dudley m.	coho	French Cr.	9855	5.1	L. ventral
Sep. 85	Dudley m.	rainbow	French Cr.	829	n/a	R. ventral
May. 86	Dudley m.	coho	French Cr.	10558	1	L. ventral
Jun. 86	mainstem	coho	French Cr.	80000	1.5	none
Oct. 86	Dudley m.	coho	French Cr.	1508	6	R. ventral
May. 87	Dudley m.	coho	French Cr.	10400	2.0	L. ventral
May. 87	mainstem	coho	French Cr.	8500	1.8	none
Jun. 87	mainstem	coho	French Cr.	44000	2.5	none
Jun. 88	Dudley m.	coho	French Cr.	4630	2.3	R. ventral

Table 3.1. Juvenile tagging summary statistics for Black Creek, 1985-1987. L.V and R.V represent fin clipped smolts captured, also expressed as a fraction of total smolt catches (% T), and as a fraction of the fry released (% S). Tag retention estimates are over a 24 h period. Tag release figures adjusted for non-retention prior to release. % Undetected figures are crude estimates, based on field observations, of the number of smolts that emigrated prior to and after the trapping operations, expressed as a fraction of the total observed smolt output.

Black Creek	1985 Season			1986 Season			1987 Season		
	Trapping	Tagging		Trapping	Tagging		Trapping	Tagging	
Start Date	May 1	May 1		Apr 15	May 7		Apr 8	Apr 29	
End Date	May 26	May 21		Jun 4	May 31		May 23	May 18	
Peak period	May 19	May 16		May 24	May 28		May 10	May 10	
Median date	May 18	May 15		May 23	May 23		May 12	May 12	
Angular deviation	4 d	3 d		6 d	5 d		7 d	5 d	
Interruptions (d)	none	none		none	none		none	none	
Total Coho	50208	% T	% S	38212	% T	% S	60909	% T	% S
No L. ventral	0	0.0	---	10	0.0	---	283	0.5	4.0
No R. ventral	0	0.0	---	1	0.0	0.0	297	0.5	1.8
No adipose	24	0.0	---	458	1.2	---	48	---	---
Juv. rainbow trout	37	---	---	144	---	---	930	---	---
Juv. cutthroat trout	60	---	---	99	---	---	281	---	---
Sculpins	n/a	---	---	858	---	---	605	---	---
Lampreys	5	---	---	21	---	---	9	---	---
Tag Code	023119	023120		023823	023824		082421	082422	
# Tagged	8066	8095		8000	8000		9000	9000	
% Retention	99.5	99.5		98.9	98.9		99.0	99.0	
# Released	8026	8054		7912	7912		8910	8910	
Tag Code	023121			023825	023841		082423	082424	
# Tagged	8095			8000	8000		9000	9000	
% Retention	99.5			98.9	98.9		99.0	99.0	
# Released	8054			7912	7912		8910	8910	
Total Tags Rel.	24134			31648			35640		
% Total Tagged	48.1			82.8			58.5		
% no tag & no adip.	0.3			2.1			0.7		
% Undetected	15.0			15.0			15.0		

Table 3.2. Juvenile tagging summary statistics for Trent River, 1985-1987. L.V and R.V represent fin clipped smolts captured, also expressed as a fraction of total smolt catches (% T), and as a fraction of the fry released (% S). Tag retention estimates are over a 24 h period. Tag release figures adjusted for non-retention prior to release. % Undetected figures are crude estimates, based on field observations, of the number of smolts that emigrated prior to and after the trapping operations, expressed as a fraction of the total smolt output.

Trent River	1985 Season			1986 Season			1987 Season		
	Trapping	Tagging		Trapping	Tagging		Trapping	Tagging	
Start date	May 1	May 22		Apr 25	May 7		Apr 25	May 4	
End date	Jun 14	Jun 13		Jun 18	May 31		Jun 8	Jun 8	
Peak period	May 25	May 30		May 20	May 20		May 10	May 10	
Median date	May 29	June 1		May 26	May 26		May 18	May 19	
Angular deviation	6 d	5 d		10 d	9 d		8 d	8 d	
Interruptions (d)	18	4		5	5		4	4	
Total Coho	12952	% T	% S	11388	% T	% S	17635	% T	% S
No L. ventral	0	0.0	---	3526	31.0	19.4	4646	26.3	13.5
No R. ventral	0	0.0	---	406	3.6	5.4	273	1.5	5.9
No adipose	1	0.0	---	0	0.0	---	46	0.3	---
Juv. rainbow trout	397	---	---	1274	---	---	2004	---	---
Juv. cutthroat trout	0	---	---	8	---	---	35	---	---
Sculpins	880	---	---	984	---	---	675	---	---
Lampreys	5	---	---	8	---	---	4	---	---
Tag Code	023122	023123		023827	023826		024127	024128	
# Tagged	4473	4512		3450	3450		5043	5100	
% Retention	99.9	99.9		99.7	99.7		99.0	99.0	
# Released	4468	4507		3439	3439		4993	5049	
Tag Code				023833			024129		
# Tagged				3664			5706		
% Retention				99.7			99.0		
# Released				3653			5649		
Total Tags Rel.	8975			10531			15691		
% Total Tagged	69.3			92.5			89.0		
% no tag & no adip.	0.07			0.28			0.9		
% Undetected	25.0			25.0			20.0		

Table 3.3. Juvenile tagging summary statistics for French Creek, 1986-1987. L.V and R.V represent fin clipped smolts captured, also expressed as a fraction of total smolt catches (% T), and as a fraction of the fry released (% S). Tag retention estimates are over a 24 h period. Tag release figures adjusted for non-retention prior to release. % Undetected figures are crude estimates, based on field observations, of the number of smolts that emigrated prior to and after the trapping operations, expressed as a fraction of the total smolt output.

French Creek	1985 Season		1986 Season			1987 Season		
	Trapping	Tagging	Trapping	Tagging		Trapping	Tagging	
Start date	none	none	Apr 18	May 9		Apr 11	Apr 11	
End date			Jun 12	Jun 6		Jun 5	May 27	
Peak period			May 27	May 27		May 15	May 15	
Median date			May 26	May 26		May 18	May 16	
Angular deviation			9 d	7 d		9 d	6 d	
Interruptions (d)			none	none		0.5	none	
Total Coho			29155	% T	% S	33917	% T	% S
No L. ventral			760	2.6	7.7	778	2.3	7.4
No R. ventral			0	0.0	---	256	0.8	17.0
No adipose			6	0.0	---	25	0.1	---
Juv. rainbow trout			2042	---	---	2484	---	---
Juv. cutthroat trout			644	---	---	788	---	---
Sculpins			198	---	---	319	---	---
Lampreys			15	---	---	28	---	---
Tag Code			023832	023831		082425	082426	
# Tagged			8000	8000		8200	8200	
% Retention			99.3	99.3		99.0	99.0	
# Released			7946	7946		8118	8118	
Tag Code			023837			082427		
# Tagged			8000			8200		
% Retention			99.3			99.0		
# Released			7946			8118		
Total Tags Rel.			23838			24354		
% Total Tagged			81.8			71.8		
% no tag & no adip.			0.6			0.8		
% Undetected			10			10		

Table 3.4. Weighted estimates of mean fork length (mm) and sample statistics for smolt populations at Black Creek, Trent River and French Creek, 1985 - 1987.

	Black Creek			Trent River			French Creek		
Survey Year	1985	1986	1987	1985	1986	1987	1985	1986	1987
Sample size	115	153	257	88	1935	184	n/a	163	250
St. Mean F.L.	96.2	117.0	116.9	86.7	100.6	96.5	n/a	91.2	94.5
SE	1.48	1.85	0.91	0.90	0.32	0.82	n/a	0.73	0.75
SD	15.90	22.80	14.50	8.49	13.90	11.23	n/a	9.32	11.81
Coef. Var.	0.17	0.19	0.12	0.10	0.14	0.12	n/a	0.10	0.13
Length range	90-169	83-170	78-172	67-111	67-155	74-150	n/a	68-119	75-168

Table 3.5. Mean fork length (mm) and sample statistics for marked and unmarked smolts smolts from the Trent River, 1985 - 1987.

	1985			1986			1987		
Group	l.v	r.v	no mark	l.v	r.v	no mark	l.v	r.v	no mark
Sample size	n/a	n/a	88	1367	365	1257	40	n/a	144
Mean F.L.	"	"	86.4	105.7	93.6	98.6	105.1	"	94.6
SE	"	"	0.90	0.37	0.41	0.31	2.34	"	8.67
SD	"	"	8.41	13.72	7.81	11.0	14.8	"	0.72
Length range	"	"	67-111	75-155	69-124	67-148	83-150	"	74-122

Table 3.6. Weight to length relationship ($W = a L^b$) coefficients, and sample statistics for smolt populations at Black Creek, Trent River and French Creek, 1985 - 1987.

	Black Creek			Trent River			French Creek		
Survey Year	1985	1986	1987	1985	1986	1987	1985	1986	1987
Sample size	115	153	257	88	278	184	n/a	163	250
a	.0170	.0139	.0184	.0182	.0194	.0305	n/a	.0259	.0103
b	2.800	2.921	2.812	2.789	2.712	2.533	n/a	2.617	3.021
r^2	0.921	0.967	0.944	0.883	0.911	0.889	n/a	0.913	0.955

Table 3.7. Weight to length relationship ($W = a L^b$) coefficients, and sample statistics for marked and unmarked smolts at Black Creek, Trent River and French Creek, 1986 - 1987.

	Black Creek			Trent River			French Creek		
Group	l.v	r.v	no mark	l.v	r.v	no mark	l.v	r.v	no mark
1986 sample	n/a	n/a	153	178	33	190	n/a	n/a	163
a	"	"	.0139	.0181	.0188	.0178	"	"	0.026
b	"	"	2.921	2.732	2.703	2.758	"	"	2.617
r^2	"	"	0.967	0.937	0.916	0.914	"	"	0.913
1987 sample	n/a	n/a	257	40	n/a	143	n/a	n/a	250
a	"	"	.0184	.0306	"	.0257	"	"	.0103
b	"	"	2.812	2.523	"	2.612	"	"	3.021
r^2	"	"	0.944	0.925	"	0.925	"	"	0.955

Table 3.8. Mean condition factor ($W \cdot L^{-3}$) and sample statistics for smolt populations at Black Creek, Trent River and French Creek, 1985 - 1987.

	Black Creek			Trent River			French Creek		
Survey Year	1985	1986	1987	1985	1986	1987	1985	1986	1987
Sample size	115	153	257	88	278	184	n/a	163	250
Mean C.F	.0107	.0115	.0116	.0116	.0101	.0107	"	.0111	.0108
SD	.0029	.0009	.0009	.0012	.0011	.0011	"	.0011	.0008
SE	.0003	.0001	.0001	.0001	.0001	.0001	"	.0001	.0001
C.V	.271	.078	.078	.103	.109	.103	"	.099	.077
C.F Range	.0095	.0065	.0061	.0056	.0086	.0088	"	.0079	.0062

Table 3.9. Mean condition factor ($W \cdot L^{-3}$) and sample statistics for marked and unmarked smolt groups at at Black Creek, Trent River and French Creek, 1986 - 1987.

	Black Creek			Trent River			French Creek		
Group	l.v	r.v	no mark	l.v	r.v	no mark	l.v	r.v	no mark
1986 sample	n/a	n/a	153	178	33	190	n/a	n/a	163
Mean C.F	"	"	.0115	.0098	.0097	.0104	"	"	.0111
SD	"	"	.0009	.0008	.0008	.0011	"	"	.0011
SE	"	"	.0001	.0001	.0001	.0001	"	"	.0001
CV	"	"	.078	.082	.083	.106	"	"	.099
Range	"	"	.0065	.0068	.0045	.0085	"	"	.0079
1987 sample	n/a	n/a	257	40	n/a	143	1	n/a	250
Mean C.F	"	"	.0116	.0101	"	.0108	.0095	"	.0108
SD	"	"	.0009	.0012	"	.0010	"	"	.0008
SE	"	"	.0001	.0002	"	.0001	"	"	.0001
CV	"	"	.078	.089	"	.093	"	"	.077
Range	"	"	.0061	.0070	"	.0075	"	"	.0062

Table 3.10. Body size and sample statistics for age 1+ and 2+ smolts from Black Creek, 1985 - 1987. Mean lengths (mm) and weights (g) for age 1+ smolts are weighted estimates. Estimates of mean length and weight for age 2+ smolts were not weighted due to insufficient sample sizes.

Survey Year	1985		1986		1987	
Smolt Age	1+	2+	1+	2+	1+	2+
Mean F.L	92.9	155.0	116.9	143.0	115.5	121.6
SD	13.7	--	22.0	14.2	14.9	12.8
# Obs.	30	1	140	13	196	10
Range	78-172	--	83-170	115-158	93-169	106-151
Mean Wt.	9.1	37.5	18.8	33.2	18.4	21.2
SD	5.1	--	10.6	8.7	6.7	6.4
# Obs.	30	1	140	13	196	10
Range	4.7-58.7	--	5.6-49.6	17.5-43.3	9.0-54.1	14.0 - 36.7

Table 3.11. Body size and sample statistics for age 1+ and 2+ smolts from French Creek, 1986 - 1987. Mean lengths and weights for age 1+ smolts are weighted estimates. Estimates of mean length and weight for age 2+ smolts were not weighted due to insufficient sample sizes.

Survey Year	1985		1986		1987	
Smolt Age	1+	2+	1+	2+	1+	2+
Mean F.L	n/a	n/a	91.2	101.8	94.1	125.7
SD	"	"	9.3	--	11.6	30.21
# Obs.	"	"	162	1	231	6
Range	"	"	68 - 119	--	75 - 140	88-168
Mean Wt.	n/a	n/a	8.83	10.7	9.25	26.6
SD	"	"	2.72	--	3.56	18.95
# Obs.	"	"	162	1	231	6
Range	"	"	4.3 - 20.5	--	4.3 - 26.5	7.5 - 54.0

Table 3.12. Estimates of maximum smolt output at Black Creek, Trent River and French Creek, 1978-1987. % Tagged at recovery figures consist of the tagged proportions among jacks and adults of each stock that escaped to each stream (from Tables 4.8 and 6.3). Figures for 1978, 1979, and 1988 are from Clark and Irvine (1989), and Fielden *et al.* (1989). All estimated outputs (from % Rec./Rel.) based on % tagged among adults. Estimated 1985 Trent River output (*) based on fin clipped fractions among adults (Table 6.3).

Stream name	Release year	% smolt population tagged	% Tagged at recovery (jacks)	% Tagged at recovery (adults)	% Tagged Rec./Rel. (max.)	Observed output	Estimated output (max.)	% smolt output counted
Black Cr.	1978	<64.5	42.5	58.8	91.1	46,405	50,860	91.2
	1979	<84.6	76.7	67.5	79.8	46,566	58,334	79.8
	1985	<48.1	25.1	17.1	35.5	50,208	141,228	35.0
	1986	<82.8	56.0	71.1	85.9	38,212	45,000	84.9
	1987	<58.5	57.0	49.4	84.4	60,909	72,129	84.4
	1988	<98.0	67.0	n/a	n/a	76,404	77,000 +	n/a
Trent R.	1985	<69.3	n/a	10.6	15.2	12,952	84,677 *	15.3
	1986	<92.5	36.0	31.4	33.9	11,388	33,547	33.9
	1987	<89.0	47.6	44.6	50.1	17,635	35,328	49.9
	1988	<98.4	31.0	n/a	n/a	18,704	23,000 +	n/a
French Cr.	1985	-	-	-	-	-	-	-
	1986	<81.8	23.0	40.7	49.7	29,155	58,596	48.9
	1987	<71.8	86.0	58.1	80.9	33,917	41,914	80.9
	1988	<96.2	87.2	n/a	n/a	27,568	29,000 +	n/a

Table 4.1. Summary of escapement enumeration statistics for Black Creek, 1985 - 1988. Run times correspond to the dates of first and last catches of adult coho at the fence. Figures on hydrological conditions are estimated from the first period of high water to the end of the season.

Black Creek	1985	1986	1987	1988
Start run	Oct. 21	Oct. 27	Nov. 11	Oct. 31
End run	Dec. 09	Nov. 24	Nov. 29	Nov. 18
Catch period	50 d	29 d	18 d	19 d
Partial counts	13	6	12	18
First freshet	Oct. 21	Nov. 18	Nov. 11	Nov. 1
Mean Level (cm)	36.6	59.2	82.8	68.5
SD Level	16.5	20.0	38.2	23.5
Mean Temp.(°C)	3.3	4.1	6.4	6.4
SD Temp.	3.20	1.92	1.48	1.96
Mean Disch. (m^3/s)	1.5	3.2	16.6	10.1
SD Discharge	1.63	6.53	18.55	10.97
Peak Discharge	7.20	31.4	60.0	41.6
# Measurements	75	73	34	58
Adult count	2892	4408	750	2122
% no adipose	0.1	17.1	71.2	49.4
% no L.V	0	0	1.3	0
% no R.V	0	0	1.3	0
# released	2833	4386	714	2122
marks applied	1643	2710	713	1743
marks/released	58.0	61.8	99.9	82.1
Jack count	259	191	528	215
% no adipose	25.1	54.3	57.4	67.0
% no L.V	0	0	0.6	0
% no R.V	0	0	0	0
# released	194	188	525	162
marks applied	24	96	510	155
marks/released	12.4	51.1	97.1	95.7
Chum count	0	0	0	1
Chinook count	0	0	0	1
Pink count	0	0	0	0
Cutthroat count	8	5	0	6

Table 4.2. Summary of escapement enumeration statistics for Trent River, 1985 - 1988. Run times correspond to the dates of first and last catches of adult coho at the fence. Figures on hydrological conditions are estimated from the first period of high water to the end of the season. In cases where two figures are given, the second figures relate to the stream population remaining after accounting for emigration of marked fish recovered in adjacent streams.

Trent River	1985	1986	1987	1988
Start run	Oct. 3	Oct. 9	Oct. 14	Oct. 1
End run	Dec. 12	Nov.18	Nov. 30	Dec. 4
Catch period	75 d	41 d	48 d	65 d
Partial counts	29	14	18	21
First freshet	Oct. 7	Oct. 26	Nov. 10	Oct. 16
Mean Level (cm)	49.1	30.8	35.0	43.0
SD Level	31.60	38.1	46.78	38.89
Mean Temp.(°C)	5.3	7.3	8.75	7.6
SD Temp.	4.33	3.73	2.75	3.00
Mean Disch. (m^3/s)	7.6	16.2	14.5	15.2
SD Discharge	12.15	41.54	26.75	26.00
Peak Discharge	71.3	230	133	153
# Measurements	75	73	69	71
Adult count	459	1076 - 895	194 - 186	367 - 355
% no adipose	1.7	14.7 - 17.6	20.1	41.7
% no L.V	0	47.6 - 40.7	7.7	16.6
% no R.V	0	0.1 - 0.1	0.5	1.1
# released	323	959 - 778	144 - 136	324 - 310
marks applied	231	956 - 775	143 - 135	321 - 307
marks/released	71.5	99.7	99.3	99.1
Jack count	42	29	12 - 11	115
% no adipose	9.5	17.2	0.8	9.3
% no L.V	0	6.9	0.8	0
% no R.V	0	3.4	0	0
# released	38	26	11 - 10	115
marks applied	26	26	10 - 09	112
marks/released	68.4	100	90.9	97.4
Chum count	117	20	93	15
Chinook count	0	0	0	0
Pink count	1	0	2	3
Cutthroat count	0	0	0	0

Table 4.3. Summary of escapement enumeration statistics for French Creek, 1985 - 1988. Run periods correspond to the dates of first and last catches of adult coho at the fence. Figures on hydrological conditions are estimated from the first period of high water to the end of the season.

French Creek	1985	1986	1987	1988
Start run	Oct. 12	Nov. 18	Nov. 22	Oct. 17
End run	Dec. 13	Dec. 10	Nov. 30	Nov. 9
Catch period	64 d	23 d	9 d	24 d
Partial counts	5	6	17	17
First freshet	Oct. 19	Nov. 18	Nov. 22	Oct. 31
Mean Level (cm)	10.2	32.6	48.7	36.0
SD Level	3.78	11.5	18.63	19.30
Mean Temp.(°C)	4.2	5.2	6.4	7.5
SD Temp.	3.80	1.28	1.03	1.91
Mean Disch. (m^3/s)	0.6	4.7	14.1	6.1
SD Discharge	0.62	4.04	12.8	5.86
Peak Discharge	2.9	16.2	41	24.0
# Measurements	61	28	21	54
Adult count	661	625	76	937
% no adipose	0	0	42.1	58.5
% no L.V	0	0.6	5.3	0.1
% no R.V	0	0.2	0	0
# released	571	558	57	853
marks applied	126	508	46	850
marks/released	22.1	91.0	80.1	99.6
Jack count	46	26	89	109
% no adipose	0	23.1	85.3	87.2
% no L.V	0	15.4	7.9	1.8
% no R.V	0	0	0	0
# released	46	24	89	109
marks applied	9	24	85	108
marks/released	19.6	100	95.5	99.1
Chum count	7	5	3	3
Chinook count	0	0	0	0
Pink count	0	0	0	0
Cutthroat count	0	0	0	3

Table 4.4. Timing, location and results of population surveys conducted at Black Creek, from 1985 to 1988. Marked coho had primary marks only. Unmarked coho lacked primary and secondary marks.

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
31.10.85	Low	12	2	0	0	0	7	1	1	0	0
12.11.85	Mid	14	4	0	0	0	2	0	1	0	0
19.11.85	Mid	15	6	0	0	0	1	0	1	0	0
10.12.85	Mid	3	2	0	0	0	0	0	0	0	0
12.12.85	M, L	21	6	0	0	0	1	0	0	0	0
22.12.85	M, L	46	11	0	0	0	0	0	0	0	0
Total		111	31	0	0	0	11	1	3	0	0
% Total			27.9	0	0	0		9.1	27.3	0	0
Unmarked		79		0	0	0	10		3	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
28.11.86	High	22	16	5	0	0	n/a	n/a	n/a	n/a	n/a
03.12.86	High	47	23	7	0	0	5	1	5	0	0
05.12.86	Mid	14	5	4	0	0	0	0	0	0	0
07.12.86	Fence	3	1	1	0	0	0	0	0	0	0
10.12.86	High	17	9	4	0	0	0	0	0	0	0
10.12.86	High	14	7	1	0	0	0	0	0	0	0
10.12.86	Mid	15	9	7	0	0	0	0	0	0	0
Total		132	70	29	0	0	5	1	5	0	0
% Total			53.3	22.0	0	0		20.0	100	0	0
Unmarked		63		11			4		4	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
29.11.87	Mid	5	5	3	0	0	3	1	2	0	0
29.11.87	Mid	11	11	5	0	0	15	8	7	0	0
12.12.87	High	25	21	19	0	0	3	1	2	0	0
Total		41	37	27	0	0	21	10	11	0	0
% Total			90.2	65.8	0	0		47.6	52.4	0	0
Unmarked		4		2	0	0	11		5	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
08.11.88	High	7	5	1	0	0	0	0	0	0	0
10.11.88	High	14	6	4	0	0	0	0	0	0	0
16.11.88	Mid	8	4	5	0	0	4	0	3	0	0
16.11.88	High	22	9	8	1	0	5	3	4	0	0
16.11.88	High	29	15	11	2	0	2	0	2	0	0
19.11.88	Fence	7	7	2	0	0	1	0	0	0	0
27.11.88	Mid	7	1	5	0	0	1	0	0	0	0
29.11.88	High	71	25	27	1	0	2	1	2	0	0
01.12.88	Fence	4	0	0	0	0	1	0	0	0	0
Total		169	72	63	4	0	16	4	11	0	0
% Total			42.6	37.2	2.4	0		25.0	68.8	0	0
Unmarked		92		24	3	0	12		8	0	0

Table 4.5. Timing, location and results of population surveys conducted at Trent River, from 1985 to 1988. Marked coho had primary marks only. Unmarked coho lacked primary and secondary marks.

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
02.11.85	Fence	3	2	0	0	0	1	1	0	0	0
08.11.85	H, L	26	6	0	0	0	1	0	0	0	0
16.11.85	H, F	59	3	0	0	0	2	2	0	0	0
20.11.85	Low	23	8	0	0	0	1	0	0	0	0
11.12.85	Low	4	0	0	0	0	0	0	0	0	0
15.12.85	High	19	5	0	0	0	2	0	1	0	0
21.12.85	High	15	1	0	0	0	0	0	0	0	0
24.12.85	Low	6	3	0	0	0	1	1	0	0	0
Total		155	28	0	0	0	8	4	1	0	0
% Total			18.1	0	0	0		50.0	12.5	0	0
Unmarked		127		0	0	0	4		1	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
08.11.86	Low	8	7	2	4	0	2	0	0	0	0
14.11.86	High	5	4	1	1	0	1	0	0	0	0
30.11.86	High	10	3	3	0	0	0	0	0	0	0
04.12.86	High	4	3	1	0	0	2	0	0	0	0
05.12.86	Low	11	5	2	4	0	1	0	1	0	0
09.12.86	High	15	9	3	2	0	0	0	0	0	0
12.12.86	High	14	5	1	3	0	0	0	0	0	0
Total		67	36	13	14	0	6	0	1	0	0
% Total			53.7	19.4	20.9	0		0	16.7	0	0
Unmarked		31		3	7	0	6		1	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
14.11.87	Mid	15	2	5	2	0	5	0	2	0	0
19.11.87	H,M,L	72	6	26	8	0	3	1	1	0	0
28.11.87	M,L	38	6	12	6	0	10	0	8	1	0
30.11.87	High	5	1	0	1	0	0	0	0	0	0
13.12.87	Mid	5	1	2	0	0	2	1	0	0	0
Total		135	16	45	17	0	20	2	11	1	0
% Total			11.8	33.3	12.6	0		10.0	55.0	5.0	0
Unmarked		109		38	16	0	10		9	1	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
23.10.88	H,L	8	7	6	1	0	8	2	1	0	0
14.11.88	H,M,L	33	7	12	2	0	8	2	4	0	0
18.11.88	High	32	7	19	2	2	11	1	6	0	0
19.11.88	Mid	16	6	7	1	0	2	0	0	0	0
25.11.88	Mid	30	9	20	13	0	1	0	1	0	0
26.11.88	Low	9	3	3	2	0	5	1	0	0	0
01.12.88	Fence	11	6	2	1	0	0	0	0	0	0
04.12.88	M,L	24	1	13	3	0	1	0	0	0	0
07.12.88	Fence	14	4	9	1	0	2	1	0	0	0
14.12.88	Mid	2	0	1	0	0	1	0	1	0	0
Total		179	50	92	26	2	39	7	13	0	0
% Total			27.9	51.3	14.5	0		17.9	33.3	0	0
Unmarked		129		57	22	0	30		11	0	0

Table 4.6. Timing, location and results of population surveys conducted at French Creek, from 1985 to 1988. Marked coho had primary marks only. Unmarked coho lacked primary and secondary marks.

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
05.11.85	M,M	44	2	0	0	0	5	1	0	0	0
14.11.85	Mid	57	4	0	0	0	9	0	0	0	0
11.12.85	Mid	23	2	0	0	0	2	0	0	0	0
23.12.85	High	45	7	0	0	0	0	0	0	0	0
Total		169	15	0	0	0	16	1	0	0	0
% Total			8.9	0	0	0		6.3	0	0	0
Unmarked		154		0	0	0	15		0	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
02.12.86	High	11	9	0	0	0	0	0	0	0	0
02.12.86	High	9	8	0	0	0	0	0	0	0	0
08.12.86	Mid	12	9	0	0	0	0	0	0	0	0
08.12.86	Mid	25	7	0	0	0	1	0	1	0	0
11.12.86	Mid	19	5	0	0	0	0	0	0	0	0
11.12.86	High	10	5	0	0	0	0	0	0	0	0
17.12.86	High	8	4	0	0	0	0	0	0	0	0
Total		94	47	0	0	0	1	0	1	0	0
% Total			50.0	0	0	0		0	100	0	0
Unmarked		45		0	0	0	1		1	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
26.11.87	Mid	3	2	1	1	0	6	2	5	0	0
27.11.87	Mid	3	2	1	0	0	2	1	1	0	0
08.12.87	High	5	1	3	0	0	2	1	2	0	0
14.12.87	Mid	5	1	0	0	0	0	0	0	0	0
Total		16	6	5	1	0	10	4	8	0	0
% Total			37.5	31.3	6.3	0		40	80.0	0	0
Unmarked		10		3	0	0	6		6	0	0

Survey date	Stream section	Adults caught	Adults marked	Adults no ad.	Adults no l.v	Adults no r.v	Jacks caught	Jack marked	Jacks no ad.	Jacks no l.v	Jacks no r.v
08.11.88	High	3	3	3	0	0	0	0	0	0	0
10.11.88	Mid	5	4	5	0	0	1	0	1	0	0
10.11.88	Mid	16	15	9	0	0	4	2	4	0	0
10.11.88	High	10	10	5	0	0	0	0	0	0	0
15.11.88	Fence	14	12	9	0	0	1	0	0	0	0
17.11.88	Mid	29	24	15	0	0	4	3	4	0	0
19.11.88	Fence	3	3	2	0	0	0	0	0	0	0
27.11.88	Mid	17	11	10	1	0	1	1	1	0	0
28.11.88	Mid	16	13	12	0	0	3	1	2	0	0
01.12.88	Fence	7	6	5	0	0	0	0	0	0	0
06.12.88	High	11	9	7	0	0	2	0	2	0	0
06.12.88	Mid	4	3	2	0	0	1	1	1	0	0
06.12.88	Fence	8	4	4	0	0	0	0	0	0	0
Total		143	117	88	1	0	17	8	15	0	0
% Total			81.8	61.5	0.7	0		47.1	88.2	0	0
Unmarked		25		11	1	0	8		7	0	0

Table 4.7. Comparison of fin clipped ratios among adults between samples collected at the fence and during stream surveys. Statistical significance at 0.05 level (*) and <0.01 level (**). Trent River figures adjusted for emigration losses. Chi-squares are all adjusted for continuity.

Black Creek		Adults			Jacks		
Year	Site	no adip.	normal	χ^2	no adip.	normal	χ^2
1985	Fence	0	111	2.55	65	194	0.04
	River	2	2890		3	8	
1986	Fence	755	3653	1.07	107	84	n/a
	River	29	110		n/a	n/a	
1987	Fence	534	216	0.31	303	225	0.05
	River	27	14		11	10	
1988	Fence	1049	1073	8.78 **	144	71	0.17
	River	63	106		11	5	

Trent River		Adults			Adults			Jacks		
Year	Site	no adip.	normal	χ^2	no L.V	normal	χ^2	no adip.	normal	χ^2
1985	Fence	8	451	1.55	0	459	-	4	38	1.49
	River	0	155		0	155	-	1	7	
1986	Fence	149	746	0.17	365	530	9.51 *	5	24	0.32
	River	13	54		14	53		1	5	
1987	Fence	38	148	6.13 *	15	171	1.32	1	11	5.12 *
	River	45	90		17	118		11	9	
1988	Fence	153	204	3.17	61	294	0.44	34	81	0.06
	River	92	87		26	153		13	26	

French Creek		Adults			Adults			Jacks		
Year	Site	no adip.	normal	χ^2	no L.V	normal	χ^2	no adip.	normal	χ^2
1985	Fence	0	661	–	0	661	-	0	46	–
	River	0	169		0	169		0	16	
1986	Fence	0	625	–	4	621	0.00	6	20	–
	River	0	94		0	94		1	0	
1987	Fence	32	44	0.28	4	72	0.20	76	13	0.00
	River	5	11		1	15		8	2	
1988	Fence	548	389	0.36	9	928	0.03	95	14	0.07
	River	88	55		1	142		15	2	

Table 4.8. Minimum estimates of escapement levels, spawner abundance and fin clipped fish by age group, in each stream, from 1985 to 1988. The fractions presented correspond to the figure above it expressed as a percentage of the total count. If no figures are available, the proportion is obtained from the stream survey data only.

Stream Year	Adult Total	Adult river	Adult no ad.	Adult no l.v	Adult no r.v	Jack Total	Jack river	Jack no ad.	Jack no l.v	Jack no r.v
Back Creek										
1985	2892	2833	2	0	0	259	194	65	0	0
		0.953	0.001	0	0		0.749	0.251	0	0
1986	4408	4386	755	0	0	191	188	107	0	0
		0.995	0.171	0	0		0.979	0.56	0	0
1987	754	718	536	1	1	539	536	308	3	0
		0.952	0.711	0.001	0.1		0.994	0.571	0.006	0
1988	2122	2122	1049	4	0	227	174	152	0	0
		1.00	0.494	0.002	0		0.767	0.670	0	0
Trent River										
1985	459	323	8	0	0	42	38	4	0	0
		0.703	0.017	0	0		0.904	0.095	0	0
1986	926	809	152	372	1	32	32	6	0	0
		0.874	0.164	0.401	0.001		1.00	0.188	0	0
1987	295	245	76	31	0	21	20	10	2	0
		0.830	0.258	0.105	0.000		0.952	0.476	0.095	0
1988	484	441	210	83	4	145	145	45	1	0
		0.911	0.433	0.171	.008		1.00	0.310	0.007	0
French Creek										
1985	661	571	0	0	0	61	61	0	0	0
		0.86	0	0	0		1.0	0	0	0
1986	625	558	0	4	1	26	24	6	4	0
		0.89	0	0.006	0.001		0.923	0.23	0.148	0
1987	86	67	35	4	0	95	95	82	7	0
		0.779	0.407	0.047	0		1.0	0.863	0.074	0
1988	962	878	559	10	1	117	117	102	2	0
		0.912	0.581	0.01	0.001		1.0	0.872	0.017	0

Table 5.1. Comparison of marked ratios between male and female adult coho, obtained during stream surveys. No figures were provided for 1985 due to the absence on information on sex in the mark-recapture dataset.

Survey Area	Survey Year	Adult Sex	With Marks	No Marks	χ^2	Prob.	Total Adult	% Marked
Black Cr.	86	F	32	22			54	59.3
		M	21	32	3.377	>0.06	53	39.6
	87	F	16	2			18	88.9
		M	19	2	0.134	>0.7	21	90.5
	88	F	27	42			69	39.0
		M	44	56	0.222	>0.6	100	44.0
Trent R.	86	F	9	19			28	32.1
		M	15	10	3.089	>0.07	25	60.0
	87	F	8	15			23	34.8
		M	5	20	0.682	>0.4	25	25.0
	88	F	23	67			90	25.6
		M	26	61	0.226	>0.6	87	29.9
French Cr.	86	F	17	22			39	43.6
		M	25	21	0.594	>0.4	46	54.3
	87	F	5	7			12	41.7
		M	1	3	0.001	>0.9	4	25.0
	88	F	65	14			79	82.3
		M	52	12	0.003	>0.9	64	81.2

Table 5.2. Adjusted census data and Bayesian estimates of the stream populations at Black Creek, 1985-1988. LB and UB represent the estimated lower and upper bounds of population size. MLE indicates the maximum likelihood estimate of population size. (+) indicates an uncertain bound determined mainly from the prior distribution. (-) indicates insufficient sample sizes.

Black Cr Census Year	Stream Survey Date	Stream Section Surveyed	Marked Adults Released	Total Adult Sample	Marked Adults Recovered	Marked Jacks Released	Total Jack Sample	Marked Jacks Recovered
1985	12.12	Mid	1643	24	8	26	-	-
	22.12	M,L	1643	46	11	26	11	1
N_{min}	N_{max}	K	2833	10000	400	194	3000	400
LB	MLE	UB	4305	6049	9074	194	284	2747+
1986	28.11	High	2710	22	16	96	-	-
	03.12	High	2710	47	23	96	5	1
	06.12	Mid	2710	17	6	96	-	-
	10.12	H,M	2710	46	25	96	-	-
N_{min}	N_{max}	K	4386	7000	400	188	3000	400
LB	MLE	UB	4450	5108	6015	188	480	2767+
1987	29.11	Mid	709	16	16	510	18	9
	12.12	High	713	25	21	510	3	1
N_{min}	N_{max}	K	718	1500	400	536	2500	400
LB	MLE	UB	727	790	910	713	1072	1924
1988	09.11	High	1734	21	11	155	-	-
	16.11	H,M,L	1740	66	35	155	12	3
	29.11	H,M,L	1743	82	26	155	4	1
N_{min}	N_{max}	K	2122	5500	400	174	2500	400
LB	MLE	UB	3491	4083	4965	284	622	1981

Table 5.3. Adjusted census data, and Bayesian estimates of the stream populations at Trent River, 1985-1988. LB and UB represent the estimated lower and upper bounds of population size. MLE indicates the maximum likelihood estimate of population size. (+) indicates an uncertain bound determined mainly from the prior distribution. (-) indicates insufficient sample sizes.

Trent R. Census Year	Stream Survey Date	Stream Section Surveyed	Marked Adults Released	Total Adult Sample	Marked Adults Recovered	Marked Jacks Released	Total Jack Sample	Marked Jacks Recovered
1985	08.11	H,L	188	29	8	20	-	-
	16.11	H,L	202	59	3	22	5	3
	20.11	Low	205	23	8	25	-	-
	13.12	H,L	231	23	5	26	3	1
	23.12	H,L	231	21	4	26	-	-
N_{min}	N_{max}	K	323	2500	400	38	442	400
LB	MLE	UB	825	1154	1672	38	48	218
1986	30.11	High	755	10	3	26	-	-
	05.12	H,L	755	15	8	26	-	-
	09.12	High	755	15	9	26	-	-
	12.12	High	755	14	5	26	6	0
N_{min}	N_{max}	K	809	2500	400	32	-	-
LB	MLE	UB	1250	1631	2233	n/a	n/a	n/a
1987	14.11	Mid	-	-	-	5	-	-
	19.11	H,M,L	79	72	6	8	-	-
	30.11	M,L	134	38	6	9	-	-
	13.12	M	135	5	1	9	20	2
N_{min}	N_{max}	K	254	2000	400	21	2500	400
LB	MLE	UB	538	880	1584	21	89	1431
1988	14.11	H,M,L	304	33	7	112	8	2
	19.11	H,M	308	48	13	112	13	1
	26.11	M,L	308	39	12	112	6	1
	01.12	L	308	11	6	112	-	-
	06.12	H,M,L	308	40	5	112	3	1
N_{min}	N_{max}	K	439	2500	400	145	2500	400
LB	MLE	UB	945	1224	1616	345	670	1962

Table 5.4. Adjusted census data, and Bayesian estimates of the stream populations at French Creek, 1985-1988. LB and UB represent the estimated lower and upper bounds of population size. MLE indicates the maximum likelihood estimate of population size. (+) indicates an uncertain bound determined mainly from the prior distribution. (-) indicates insufficient sample sizes.

French Census Year	C Stream Survey Date	Stream Section Surveyed	Marked Adults Released	Total Adult Sample	Marked Adults Recovered	Marked Jacks Released	Total Jack Sample	Marked Jacks Recovered
1985	05.11	M,M	120	44	2	8	-	-
	14.11	Mid	121	57	4	9	16	1
	11.12	Mid	125	23	2	9	-	-
	23.12	High	126	45	7	9	-	-
N_{min}	N_{max}	K	571	3000	400	61	2000	400
LB	MLE	UB	879	1381	2401	61	143	2231
1986	02.12	High	505	20	17	24	-	-
	08.12	Mid	508	37	16	24	1	0
	11.12	H,M	508	29	10	24	-	-
	17.12	High	508	8	4	24	-	-
N_{min}	N_{max}	K	558	2000	400	24	-	-
LB	MLE	UB	852	1016	1289	n/a	n/a	n/a
1987	27.11	Mid	46	6	4	85	10	4
	08.12	High	46	5	1	85	-	-
	14.12	Mid	46	5	1	85	-	-
N_{min}	N_{max}	K	67	1000	400	95	1000	400
LB	MLE	UB	67	123	324	110	212	712
1988	10.11	H,M	849	34	32	108	5	2
	15.11	L	850	14	12	108	-	-
	18.11	M,L	850	32	27	108	5	3
	28.11	Mid	850	33	24	108	4	2
	01.12	L	850	7	6	108	-	-
	06.12	H,M,L	850	23	16	108	3	1
N_{min}	N_{max}	K	878	2000	400	117	1000	400
LB	MLE	UB	965	1038	1131	143	230	478

Table 5.5. Estimates of the stream populations of adults (above), and jacks (below) at Black Creek, Trent River, and French Creek, 1985-1988, generated from the open model. In each case, the best fitting combination of parameters is given (Optimal set), as well as the maximum likelihood estimate of abundance and associated credibility regions (N^o, LB-UB). The maximum likelihood estimate obtained is also expressed as a fraction of the closed model estimate (N^o/N^c).

Stream - Yr.	Upmigr. pattern	Upmigr. limit	Optimal set (N', ϕ', σ')	Pop. size limits	N^o, LB-UB Marginal distr.	Stream life range ($\bar{x}$)	N^o / N^c (%)
B.C '85	Uniform	Dec. 6	5433, 15, .40	N	5933, 4583-7483	4 - 24	98.0
B.C '86	Uniform	Dec. 6	4596, 5, .64	N	4796, 4636-5536	5 - 32	93.9
B.C '87	D/U	Dec. 7	789, 22, .15	N	749, 739-879	5 - 25	94.8
B.C '88	Decreasing	Dec. 6	3222, 16, .5	Y	3122, 2750-3600	6 - 19	76.5
T.R '85	Uniform	Dec. 11	773, 14, .15	N	973, 698-1073	10 - 18	84.3
T.R '86	Decreasing	Nov. 29	1028, 20, .25	N	1078, 903-1428	6 - 34	66.1
T.R '87	Decreasing	Nov. 24	995, 12, .35	Y	995, 680-1380	11 - 16	112.5
T.R '88	Uniform	Nov. 20	912, 31,.15	Y	862, 710-1062	25 - 32	70.4
F.C '85	Decreasing	Dec. 6	1271, 14, .7	N	1021, 796-1496	18 - 32	73.9
F.C '86	Decreasing	Dec. 6	808, 20, .23	Y	808, 738-898	19 - 22	79.5
F.C '87	Decreasing	Dec. 6	97, 8, .55	N	107, 70-210	6 - 24	87.0
F.C '88	Decreasing	Dec. 6	993, 24, .4	Y	993, 935-1053	24 - 27	95.7
B.C '85	-	-	n/a	-	n/a	n/a	-
B.C '86	-	-	n/a	-	n/a	n/a	-
B.C '87	Decreasing	Dec. 7	880, 23, .15	N	730, 620-1500	6 - 33	68.1
B.C '88	Decreasing	Dec. 5	343, 6, .95	Y	343, 220-770	6 - 21	55.1
T.R '85	-	-	n/a	-	n/a	n/a	-
T.R '86	-	-	n/a	-	n/a	n/a	-
T.R '87	-	-	n/a	-	n/a	n/a	-
T.R '88	Decreasing	Nov. 21	427, 5, .85	Y	477, 300-1270	8-30	71.1
F.C '85	-	-	n/a	-	n/a	-	-
F.C '86	-	-	n/a	-	n/a	-	-
F.C '87	Decreasing	Dec. 1	216, 26, .15	N	216, 126-566	5 - 26	101.9
F.C '88	Decreasing	Dec. 6	217, 33, .15	N	192, 145-317	6 - 34	83.5

Table 5.6. Estimates of the stream population of jacks based on jack-to-adult ratio for Black Creek, Trent River and French Creek, 1985-1988. The relative abundance of jacks is expressed as the Jack-to-Adult ratio observed during the escapement enumeration and stream surveys. Jack and adult figures are minimum escapement counts from Table 4.8. Estimates of adult abundance and associated bounds were obtained from Table 5.5.

Stream/Yr	# Jacks in stream	# Adults in stream	Jack / Adult	Conf. int. 95%	Adult Pop. (N^o)	Jack Pop. (N)	Jack Pop. (LB - UB)
BC '85	194	2833	0.068	6.8 - 7.9	5933	403	313 - 595
BC '86	188	4386	0.043	4.2 - 5.0	4796	206	199 - 277
BC '87	536	718	0.747	74.5 - 77.5	749	560	550 - 681
BC '88	174	2122	0.082	8.1 - 9.5	3122	256	225 - 342
TR '85	38	323	0.118	9.4 - 15.2	973	115	65 - 108
TR '86	32	809	0.396	3.0 - 5.5	1078	41	26 - 78
TR '87	20	245	0.833	5.6 - 12.6	995	83	42 - 230
TR '88	145	441	0.328	29.9 - 36.7	862	281	212 - 390
FC '85	61	571	0.107	8.7 - 12.7	1021	109	69 - 190
FC '86	24	558	0.043	2.7 - 6.3	808	35	20 - 56
FC '87	95	67	1.418	123.4 - 165.2	107	123	116 - 259
FC '88	117	878	0.133	11.8 - 15.4	993	131	110 - 162

Table 5.7. Estimates of total escapement and spawning population sizes for adults (above), and jacks (below) at Black Creek, Trent River and French Creek, 1984-1988. # Collected represent the number of fish removed at the fence or in the stream during the season.

Stream/yr.	Pop. size estimate	# Collected Fence	Estimated Escapement	Esc. LB - UB	# Collected Stream	Estimated Spawners	Spawners LB - UB
BC '84	Visual	0	5990	n/a	30	5060	n/a
BC '85	O. model	59	5992	4742-7542	0	5933	4583-7483
BC '86	O. model	22	4818	4658-5558	0	4796	4636-5536
BC '87	O. model	36	785	775-915	0	749	739-879
BC '88	O. model	0	3122	2750-3600	18	3104	2732-3582
TR '84	Visual	0	1109	n/a	20	1089	n/a
TR '85	O. model	136	1109	834-1209	57	916	641-1016
TR '86	O. model	117	1195	1020-1545	10	1068	893-1418
TR '87	O. model	50	1045	730-1430	4	991	676-1376
TR '88	O. model	43	905	753-1105	5	857	705-1057
FC '84	Visual	0	1111	n/a	20	1091	n/a
FC '85	O. model	90	1111	886-1586	10	1011	786-1486
FC '86	O. model	67	875	805-965	0	808	738-898
FC '87	O. model	19	126	89-229	0	107	70-210
FC '88	O. model	81	1074	1016-1134	0	993	935-1053
BC '84	Visual	0	350	n/a	0	350	n/a
BC '85	C. model	65	349	259-2812	0	284	194-2747
BC '86	C. model	3	483	195-2770	0	480	188-2767
BC '87	O. model	3	733	623-1503	0	730	620-1500
BC '88	O. model	53	396	273-823	0	343	220-770
TR '84	Visual	0	52	n/a	0	52	n/a
TR '85	C. model	4	52	42-222	0	48	38-218
TR '86	J/A ratio	3	44	36-81	0	41	26-78
TR '87	J/A ratio	1	84	43-231	0	83	42-230
TR '88	O. model	0	477	300-1270	0	477	300-1270
FC '84	Visual	0	143	n/a	0	143	n/a
FC '85	C. model	0	143	61-2231	0	143	61-2231
FC '86	J/A ratio	2	35	23-59	0	33	20-56
FC '87	O. model	0	216	126-566	0	216	126-566
FC '88	O. model	1	193	146-318	0	192	145-317

Table 6.1. Coded wire tag recoveries at Black Creek, 1985 to 1988. Tags collected at the fence and during stream surveys are combined.

Recovery Year	Tag code	Number recovered	Age group	Missing fins	Brood Origin	% contribution tagged pop.	Tags in escapement
1985	023119	19	Jack	AD	'83 Black Cr.	.306	27
	023120	26	Jack	AD	'83 Black Cr.	.419	37
	023121	17	Jack	AD	'83 Black Cr.	.275	24
	No pin	2	Jack	AD	'83	-	-
	No pin	1	Adult	AD	'82	-	-
1986	-	-	Jacks	AD	'84 Black Cr.	0.00	270
	023119	4	Adult	AD	'83 Black Cr.	.143	118
	023120	15	Adult	AD	'83 Black Cr.	.536	442
	023121	9	Adult	AD	'83 Black Cr.	.321	265
1987	082421	4	Jack	AD	'85 Black Cr.	.800	334
	082423	1	Jack	AD	'85 Black Cr.	.200	84
	023823	16	Adult	AD	'84 Black Cr.	.410	229
	023824	5	Adult	AD	'84 Black Cr.	.128	71
	023825	11	Adult	AD	'84 Black Cr.	.283	157
	023841	7	Adult	AD	'84 Black Cr.	.179	100
	No pin	2	Adult	AD	'84 Black Cr.	-	-
1988	082440	2	Jack	AD	'86 Black Cr.	.035	9
	082441	5	Jack	AD	'86 Black Cr.	.088	23
	082442	2	Jack	AD	'86 Black Cr.	.035	9
	082443	1	Jack	AD	'86 Black Cr.	.018	5
	082446	1	Jack	AD	'86 Black Cr.	.018	5
	082447	1	Jack	AD	'86 Black Cr.	.018	5
	082449	10	Jack	AD	'86 Black Cr.	.175	46
	082450	19	Jack	AD	'86 Black Cr.	.333	88
	082451	15	Jack	AD	'86 Black Cr.	.263	70
	082461	1	Jack	AD	'86 Black Cr.	.017	5
	082421	12	Adult	AD	'85 Black Cr.	.353	544
	082422	8	Adult	AD	'85 Black Cr.	.235	362
	082423	7	Adult	AD	'85 Black Cr.	.206	318
	082424	7	Adult	AD	'85 Black Cr.	.206	318
	No pin	7	Adult	AD	'85	-	-

Table 6.2. Coded wire tag recoveries at Trent River, 1985 to 1988. Tags collected at the fence and during stream surveys are combined.

Recov. Year	Tag code	Number recovered	Age group	Missing fins	Brood year Rel. loc.	% Contrib. CWT group	Tags in escap.	Exp. factor	Strays in escapement
1985	022846	1	Jack	AD	'83 Porpoise Bay	.250	1.24	1.1	1.36
	022915	1	Jack	ADLV	'83 Puntledge R.	.250	1.24	3.8	4.71
	022938	1	Jack	AD	'83 L.Qualicum R.	.250	1.24	1.0	1.24
	082249	1	Jack	ADRV	'83 Capilano R.	.250	1.24	2.8	3.47
	022643	2	Adult	AD	'82 Puntledge R.	.222	4.28	18.3	78.3
	022644	2	Adult	AD	'82 Puntledge R.	.222	4.28	12.6	53.9
	022645	4	Adult	AD	'82 Puntledge R.	.444	8.56	14.7	125.8
	022723	1	Adult	AD	'82 Puntledge R.	.112	2.16	11.6	25.1
	No pin	2	Adult	AD	'82 (hatchery)	-	-	-	-
1986	023437	1	Jack	AD	'84 Quinsam R.	.333	2.8	-	29
	No pin	2	Jack	AD	'84 (Trent R. ?)	.000	5.4	-	15
	022912	1	Adult	AD	'83 Puntledge R.	.018	3.5	14.7	51.5
	022913	1	Adult	AD	'83 Puntledge R.	.018	3.5	7.4	25.9
	022914	2	Adult	AD	'83 Puntledge R.	.036	7.1	3.8	27.0
	022915	6	Adult	ADLV	'83 Puntledge R.	.109	21.4	3.8	81.3
	022923	1	Adult	ADLV	'83 Quinsam R.	.018	3.5	1.6	5.6
	022944	2	Adult	AD	'83 Puntledge R.	.036	7.1	7.4	52.5
	022946	20	Adult	ADLV	'83 Puntledge R.	.435	85.5	3.8	324.9
	023122	9	Adult	AD	'83 Trent R.	.165	32.3	-	-
	023123	9	Adult	AD	'83 Trent R.	.165	32.3	-	-
	No pin	4	Adult	ADLV	'83 (hatchery)	-	-	-	-
1987	-	-	Jack	AD	'85 (Trent R. ?)	.000	40.0	-	-
	023125	1	Adult	AD	'84 Rosewall Cr.	.059	15.9	1.0	18.1
	023152	1	Adult	AD	'84 Puntledge R.	.059	15.9	1.8	28.6
	023432	2	Adult	AD	'84 Rosewall Cr.	.118	31.8	1.0	31.8
	023434	2	Adult	AD	'84 Rosewall Cr.	.118	31.8	1.0	31.8
	023445	1	Adult	AD	'84 Puntledge R.	.059	15.9	26.0	413.4
	023826	2	Adult	AD	'84 Trent R.	.118	31.8	-	-
	023827	4	Adult	AD	'84 Trent R.	.235	63.4	-	-
	023833	4	Adult	AD	'84 Trent R.	.235	63.4	-	-
	No pin	5	Adult	AD	'84	-	-	-	-
1988	082438	2	Jack	AD	'86 Trent R.	.666	98.5	-	-
	082439	1	Jack	AD	'86 Trent R.	.333	49.2	-	-
	024127	19	Adult	AD	'85 Trent R.	.328	128.5	-	-
	024128	18	Adult	AD	'85 Trent R.	.310	121.5	-	-
	024129	20	Adult	AD	'85 Trent R.	.345	135.1	-	-
	024151	1	Adult	AD	'85 Puntledge R.	.017	6.7	6.3	42.2
	No pin	8	Adult	AD	'85	-	-	-	-

Table 6.3. Estimates of CWT contribution, stock composition, and tagged proportions at Trent River, 1985 to 1988. Figures within brackets are the corresponding estimates based on fin clipped proportions.

Stream name	Recovery Year	Stock Origin	Jack population			Adult population		
			Total Abundance	% Total escapement	% Tagged Trent stock	Total abundance	% Total escapement	% Tagged Trent Stock
Trent R.	1985	Porpoise Bay	1.36	2.6	-	-	-	-
		L.Qualicum	1.24	2.4	-	-	-	-
		Capilano R.	3.47	6.7	-	-	-	-
		Puntledge R.	4.7	9.0	-	189.1	17.1	-
		Trent R.	41.2	79.2	n/a	919.9	82.9	0.0
	1986	Quinsam R.	29	66.0	-	6	0.5	-
		Puntledge R.	-	-	-	563	47.2	-
		Trent R.	14	34.0	36.0	626 (609)	52.3 (51)	10.3 (10.6)
	1987	Rosewall Cr.	-	-	-	81.7	7.8	-
		Puntledge R.	-	-	-	442.0	42.3	-
		Trent R.	84	100.0	47.6	521.3	49.9	31.4
	1988	Puntledge R.	-	-	-	42.2	4.7	-
		Trent R.	477	100.0	31.0	862.8	95.3	44.6

Table 6.4. Coded wire tag recoveries at French Creek, 1985 to 1988. Tags collected at the fence and during stream surveys are combined.

Recovery Year	Tag code	Number recovered	Age group	Missing fins	Brood Origin	% contribution tagged pop.	Tags in escapement
1986	023832	2	Jack	AD	'84 French Cr.	1.00	8.1
1987	082427	3	Jack	AD	'85 French Cr.	1.00	186.4
	023831	5	Adult	AD	'84 French Cr.	.454	23.3
	023832	3	Adult	AD	'84 French Cr.	.272	34.3
	023837	3	Adult	AD	'84 French Cr.	.272	34.3
	No pin	2	Adult	AD	'84	-	-
1988	082435	4	Jack	AD	'86 French Cr.	.500	84.1
	082436	3	Jack	AD	'86 French Cr.	.375	63.1
	082437	1	Jack	AD	'86 French Cr.	.175	21.0
	No pin	1	Jack	AD	'86	-	-
	082425	29	Adult	AD	'85 French Cr.	.367	229.0
	082426	19	Adult	AD	'85 French Cr.	.241	150.4
	082427	31	Adult	AD	'85 French cr.	.392	244.6
	No pin	7	Adult	AD	'85	-	-

Table 6.5. Mean length (Post-orbital hypural) and associated statistics for adults sampled at Black Creek, Trent River and French Creek, 1984 to 1988. L_m/L_f corresponds to the ratio of the average length of males over females sampled.

Survey Location	Survey year	Adult Sex	n	L. range (min-max)	Length ($\bar{x}$, cm)	Length S.D.	Mann-Whit. Prob.	L_m/L_f (%)	Length ($\bar{x}$,comb.)	Length S.D	n
Black Cr.	1984	M	9	42-62	52	6					
		F	19	43-60	53	4	.860	98.1	53	5	28
	1985	M	55	40-65	52	6					
		F	101	35-70	54	5	.130	96.3	53	5	156
	1986	M	52	32-67	47	8					
		F	75	37-64	50	5	.016	94.0	49	7	127
	1987	M	36	34-58	46	7					
		F	31	37-56	46	5	.980	100.0	46	6	67
	1988	M	62	31-61	44	6					
		F	41	36-61	48	5	.0006	91.7	46	6	103
Trent R.	1984	M	25	32-61	46	7					
		F	18	39-59	48	5	.080	95.8	47	6	43
	1985	M	23	36-59	48	6					
		F	87	39-69	50	5	.090	96.0	50	5	110
	1986	M	48	32-60	46	6					
		F	48	40-60	49	5	.010	93.9	48	6	96
	1987	M	30	35-56	45	5					
		F	48	40-58	47	4	.040	95.7	46	4	78
	1988	M	105	34-56	42	5					
		F	99	31-57	45	5	.0001	93.3	43	5	204
French Cr.	1984	M	10	38-47	42	3					
		F	12	37-49	44	3	.134	95.5	43	4	22
	1985	M	65	34-69	49	7					
		F	72	38-65	48	6	.171	102.1	48	7	137
	1986	M	46	37-60	46	6					
		F	36	35-58	47	5	.470	97.9	47	6	82
	1987	M	8	38-51	44	4					
		F	16	37-55	48	5	.056	91.7	47	5	24
	1988	M	87	30-54	41	5					
		F	100	33-55	45	4	.0001	91.1	43	5	187

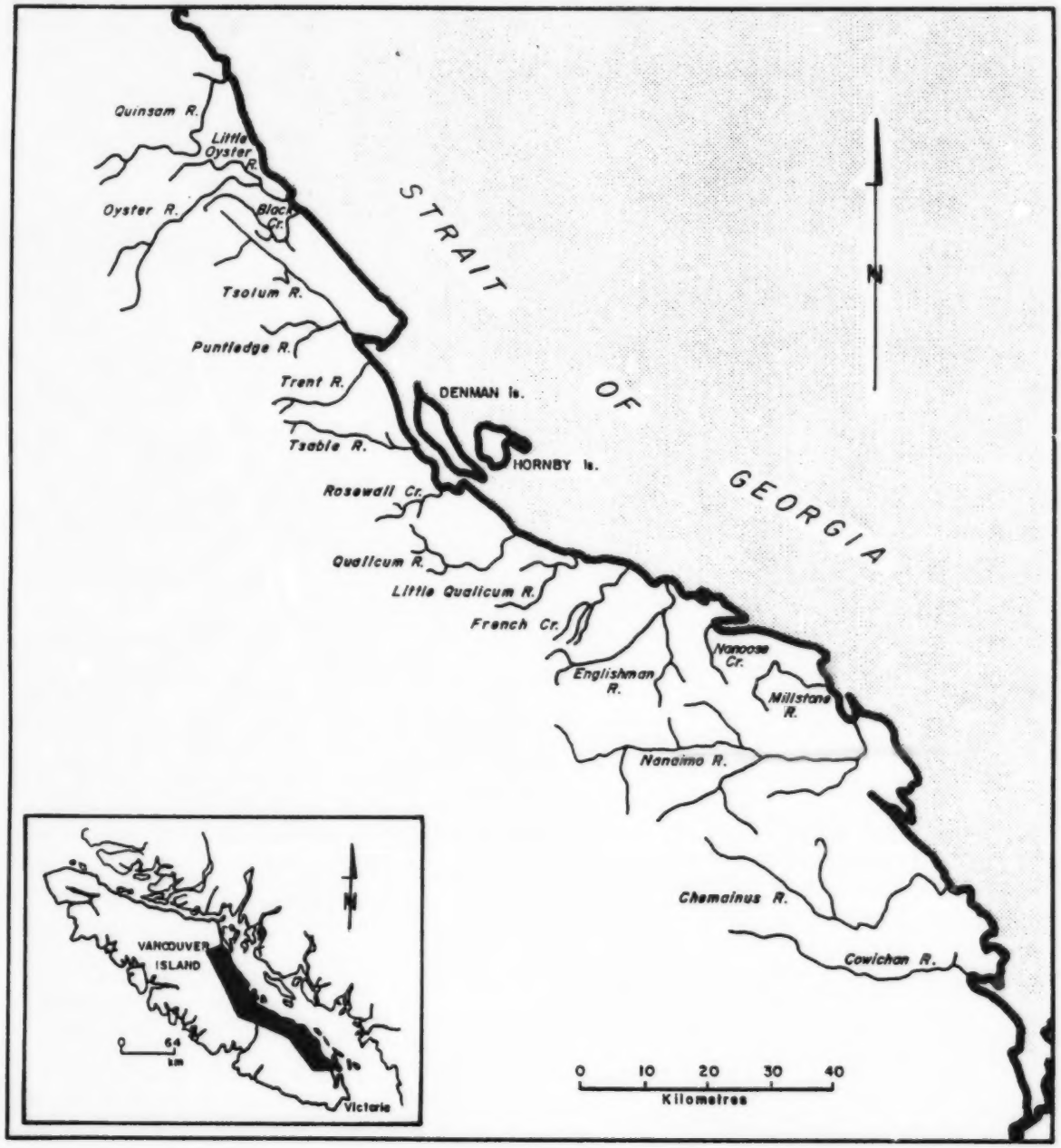

Figure 1.1. Geographical location of study site

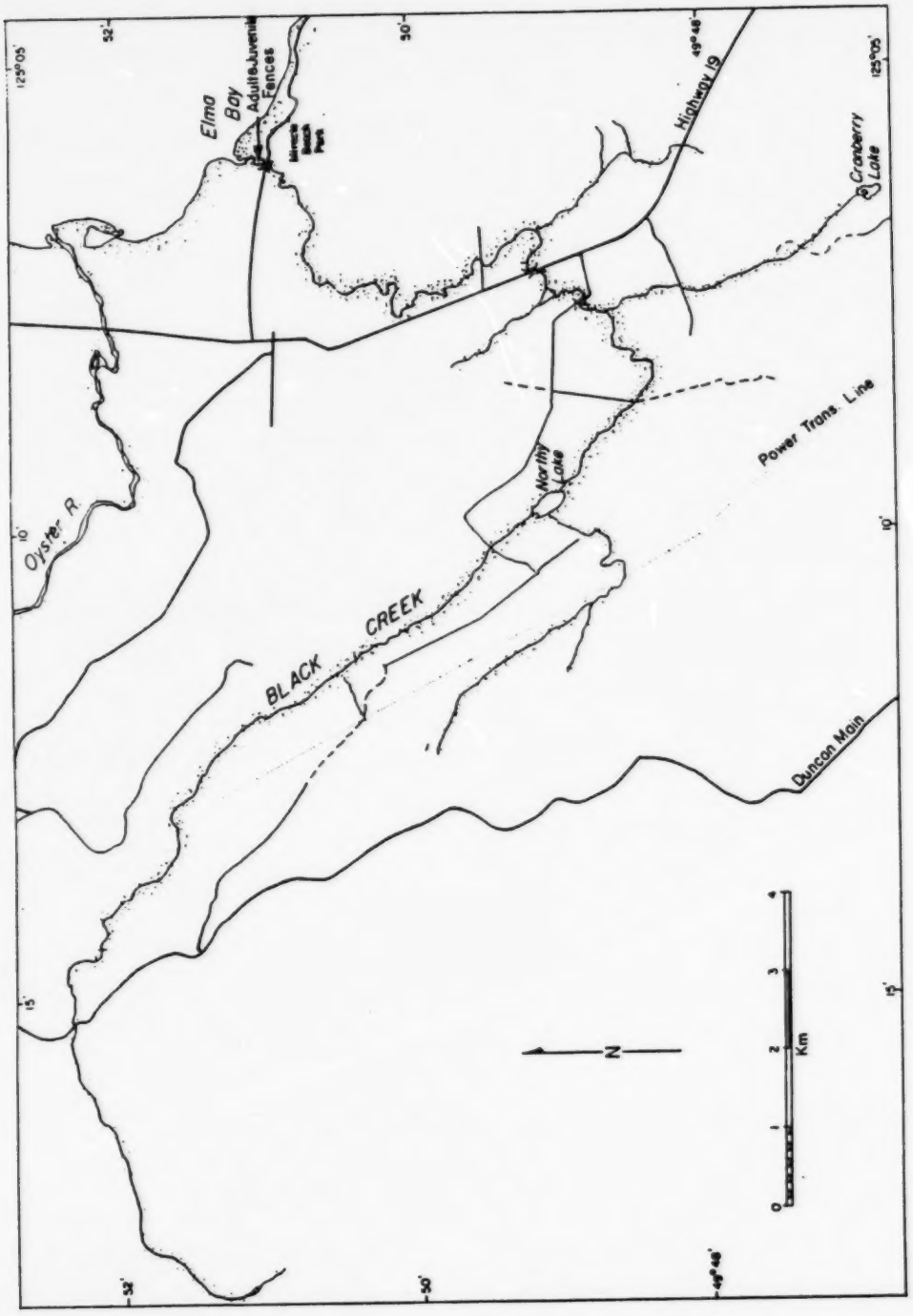

Figure 2.1. Geographical profile of Black Creek, and location of access points

Figure 2.2. Geographical profile of Trent River, and location of access points

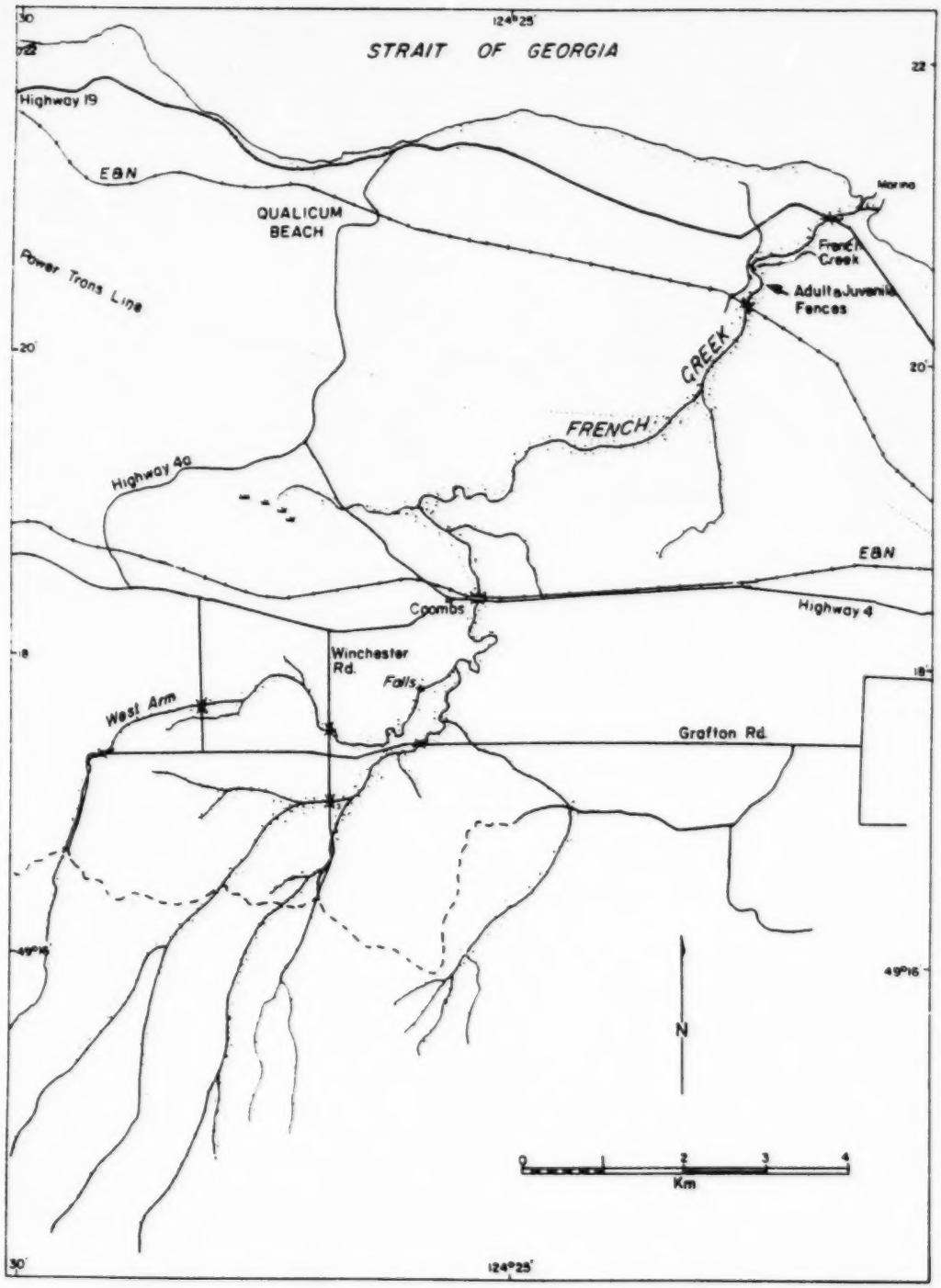

Figure 2.3. Geographical profile of French Creek, and location of access points.

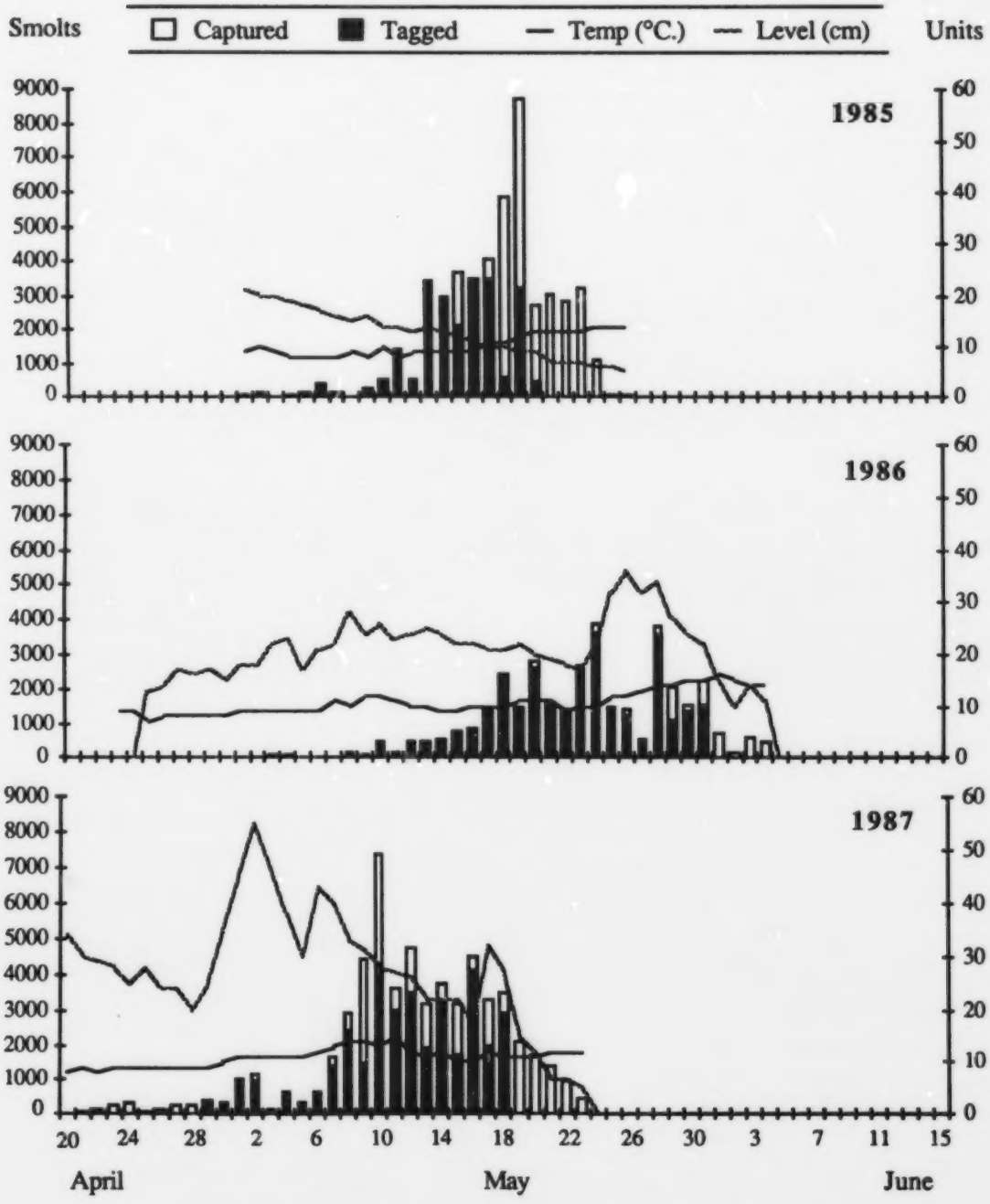

Figure 3.1. Outmigration pattern, hydrological conditions, and distribution of tagging effort at Black Creek, 1985 to 1987.

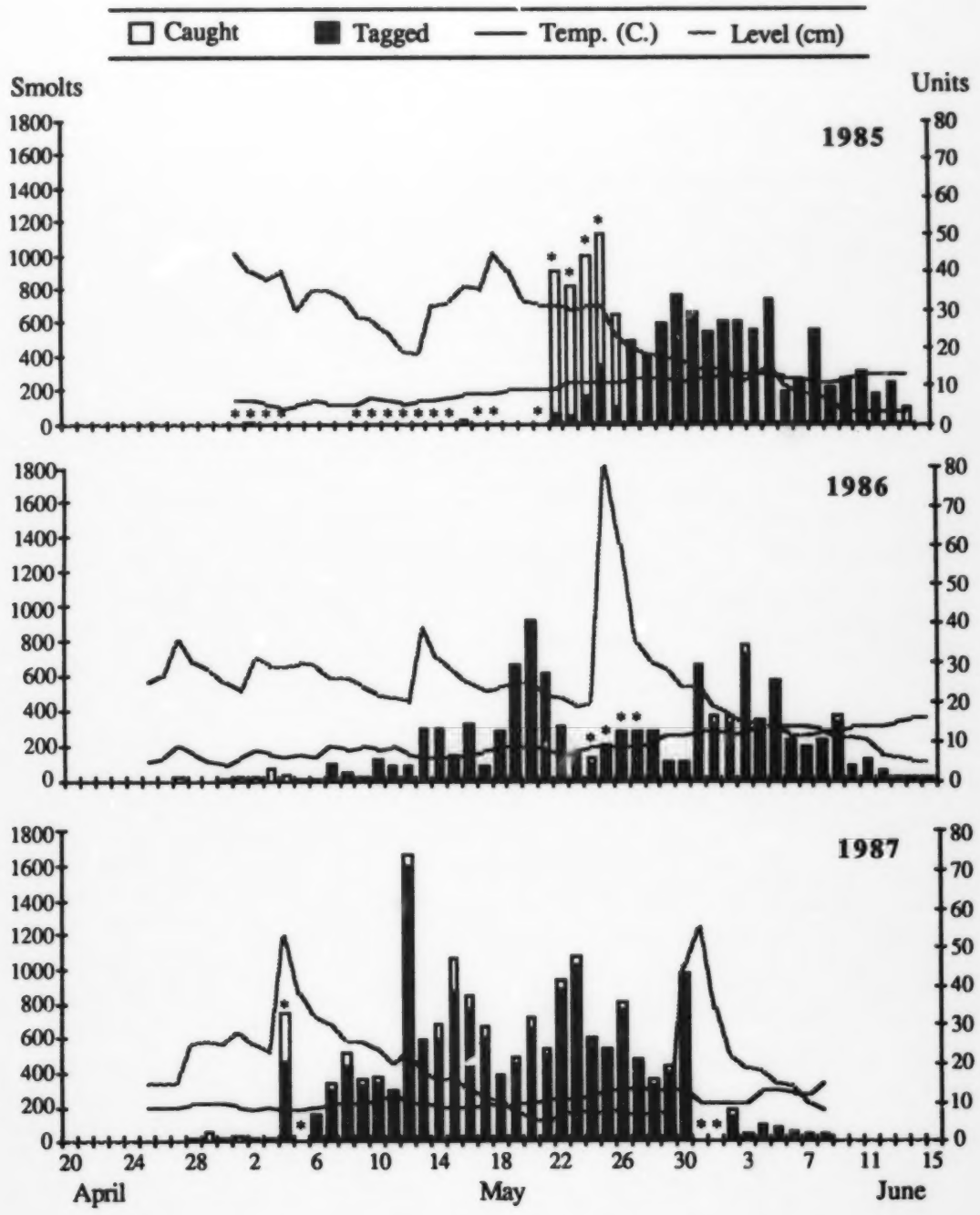

Figure 3.2. Outmigration pattern, hydrological conditions, and distribution of tagging effort at Trent River 1985 - 1987. (*) Denotes incomplete daily counts.

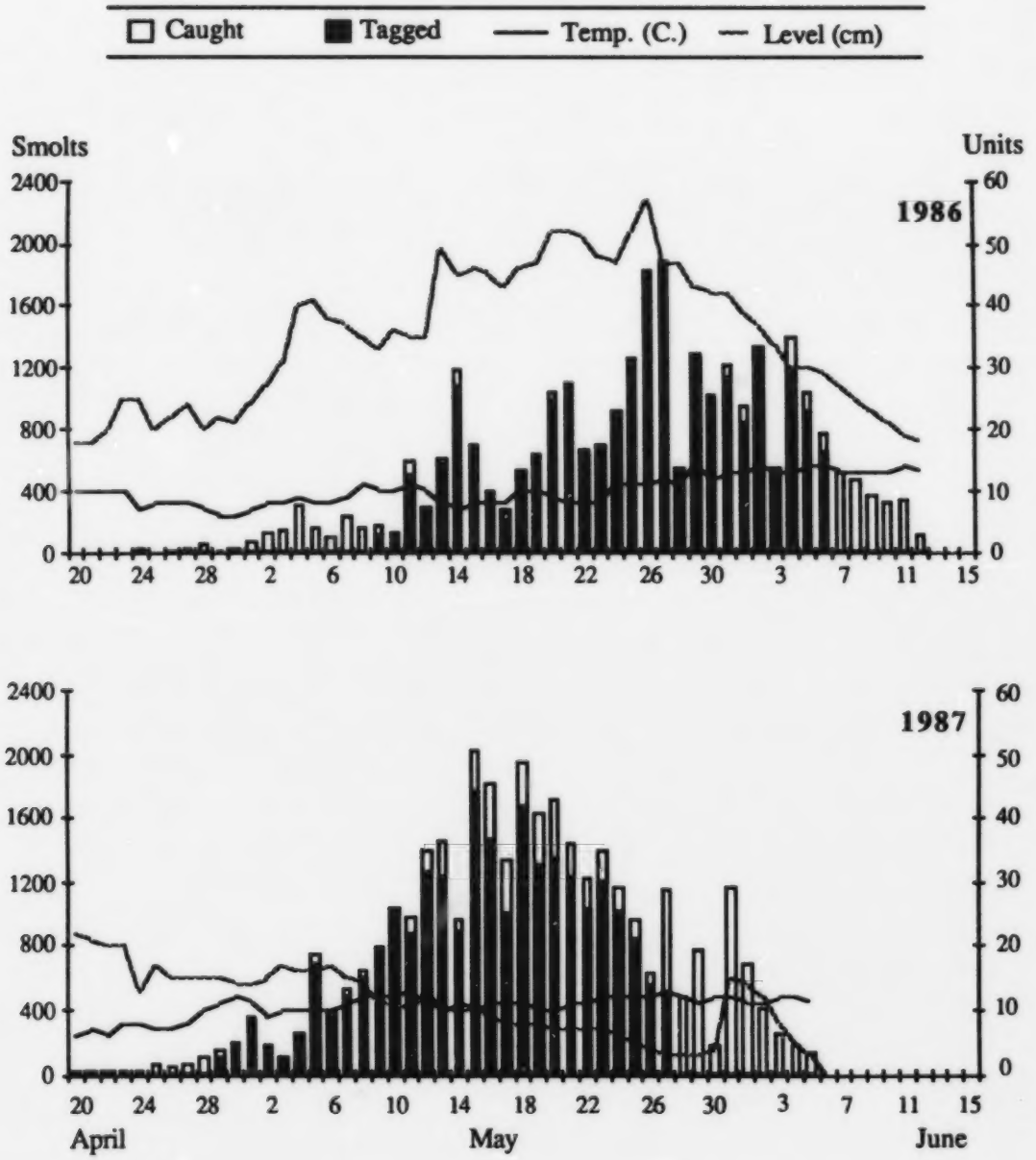

Figure 3.3. Outmigration pattern, hydrological conditions, and distribution of tagging effort at French Creek 1986 - 1987.

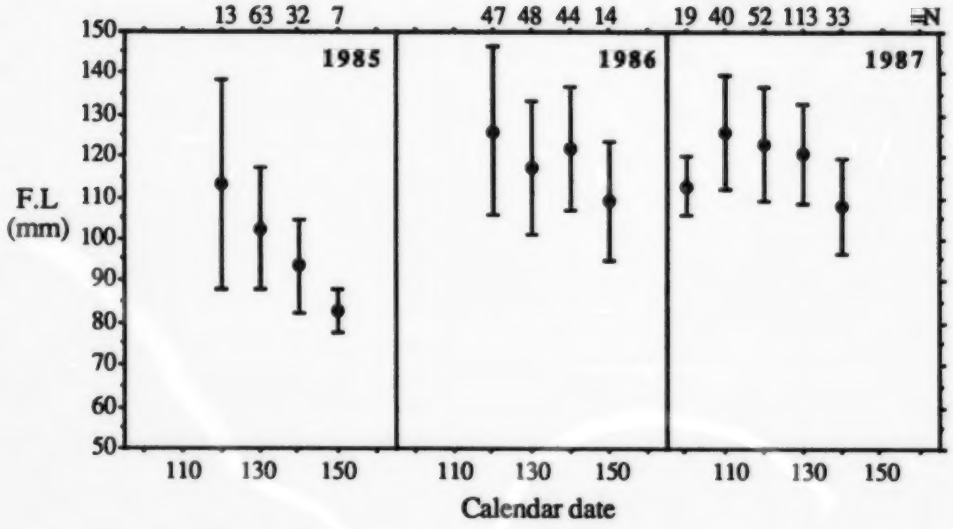

Figure 3.4. Black Creek smolt size during outmigration periods, 1985-1987. Time periods are in calendar d. For each 10 d interval, the mean fork length (mid dot) ± one standard deviation, and the corresponding sample size are given.

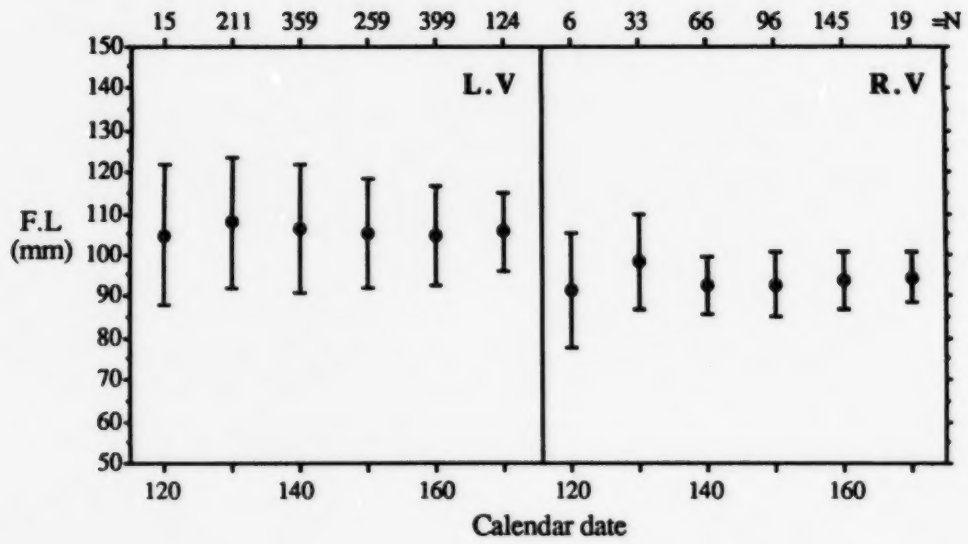

Figure 3.5. Trent river smolt size during 1986 outmigration. Sizes are for fin clipped smolts only. For each 10 d interval, the mean fork length (mid dot) ± one standard deviation, and the corresponding sample size are given.

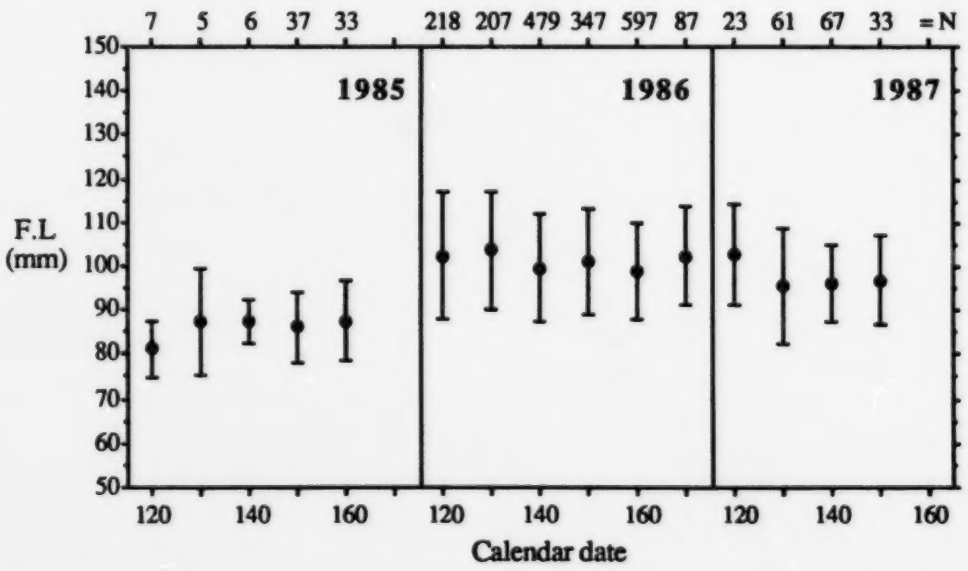

Figure 3.6. Trent river smolt size during outmigration periods, 1985-1987. Marked and unmarked smolts sizes were combined. For each 10 d interval, the mean fork length (mid dot) ± one standard deviation, and the corresponding sample size (above) are given.

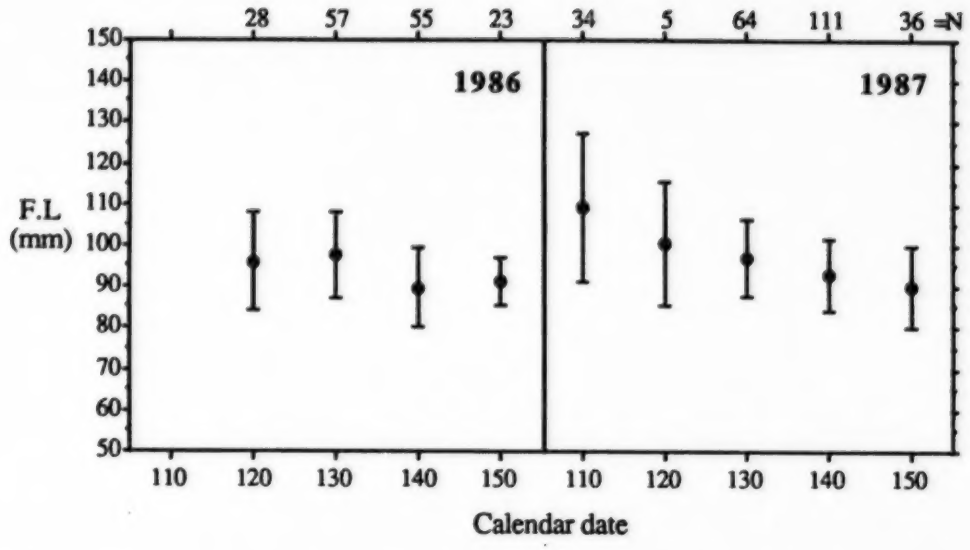

Figure 3.7. French Creek smolt size during outmigration periods, 1986-1987. Marked and unmarked smolts sizes were combined. For each 10 d interval, the mean fork length (mid dot) ± one standard deviation, and the corresponding sample size (above) are given.

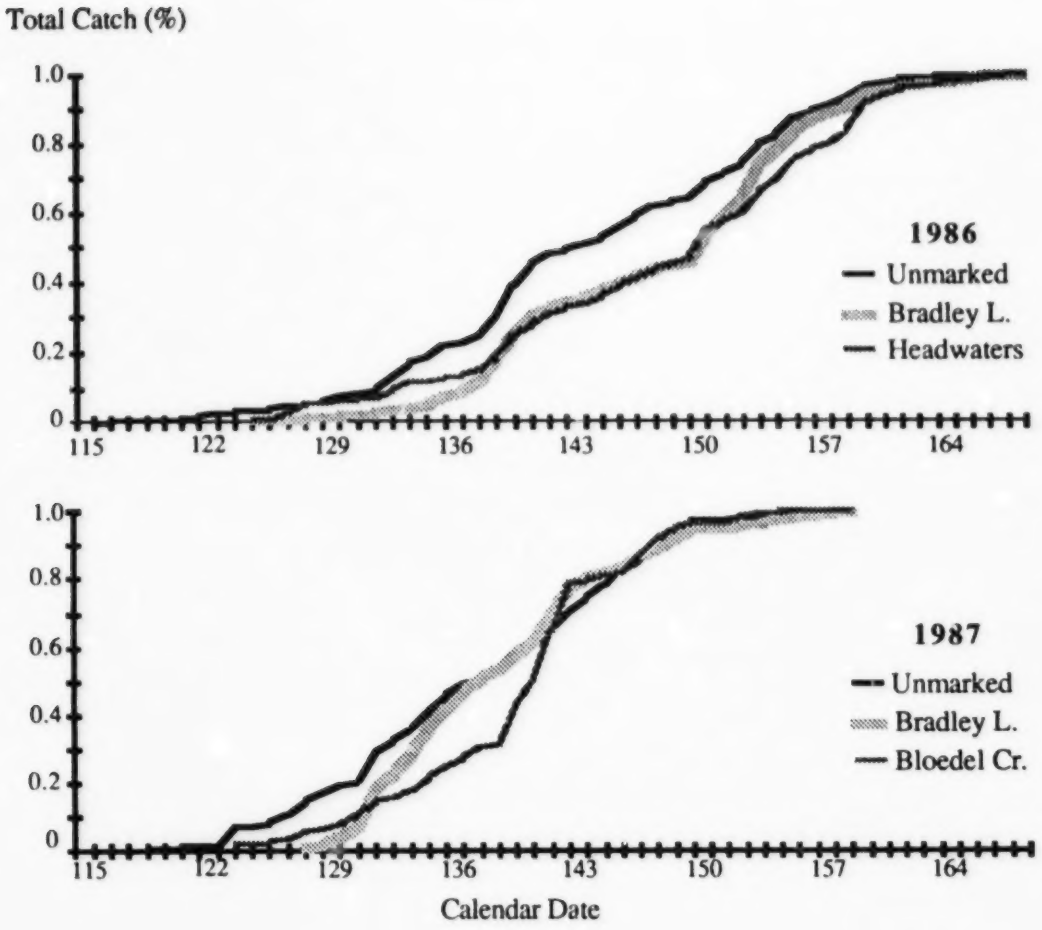

Figure 3.8. Outmigration patterns of marked and unmarked smolts at Trent river during 1986 (above) and 1987 (below). The cumulative fractions of the total catch of each group are presented separately. The marks used were; Bradley Lake (L.V), Bloedel Creek (R.V), and Headwaters (R.V).

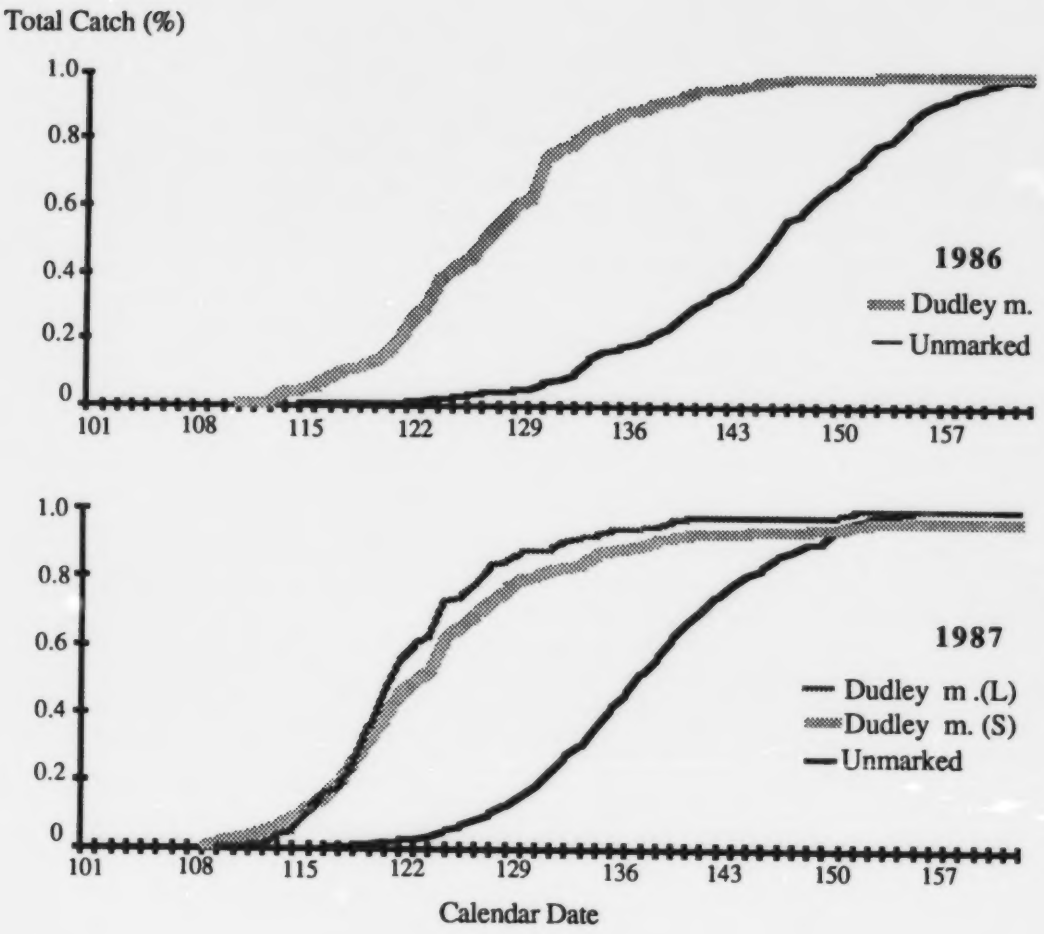

Figure 3.9. Outmigration patterns of marked and unmarked smolts at French Creek during 1986 (above) and 1987 (below). The cumulative fractions of the total catch of each group are presented separately. The marks used were; 1986 Dudley marsh (LV) , 1987 Dudley marsh small (LV), and 1987 Dudley marsh large (RV).

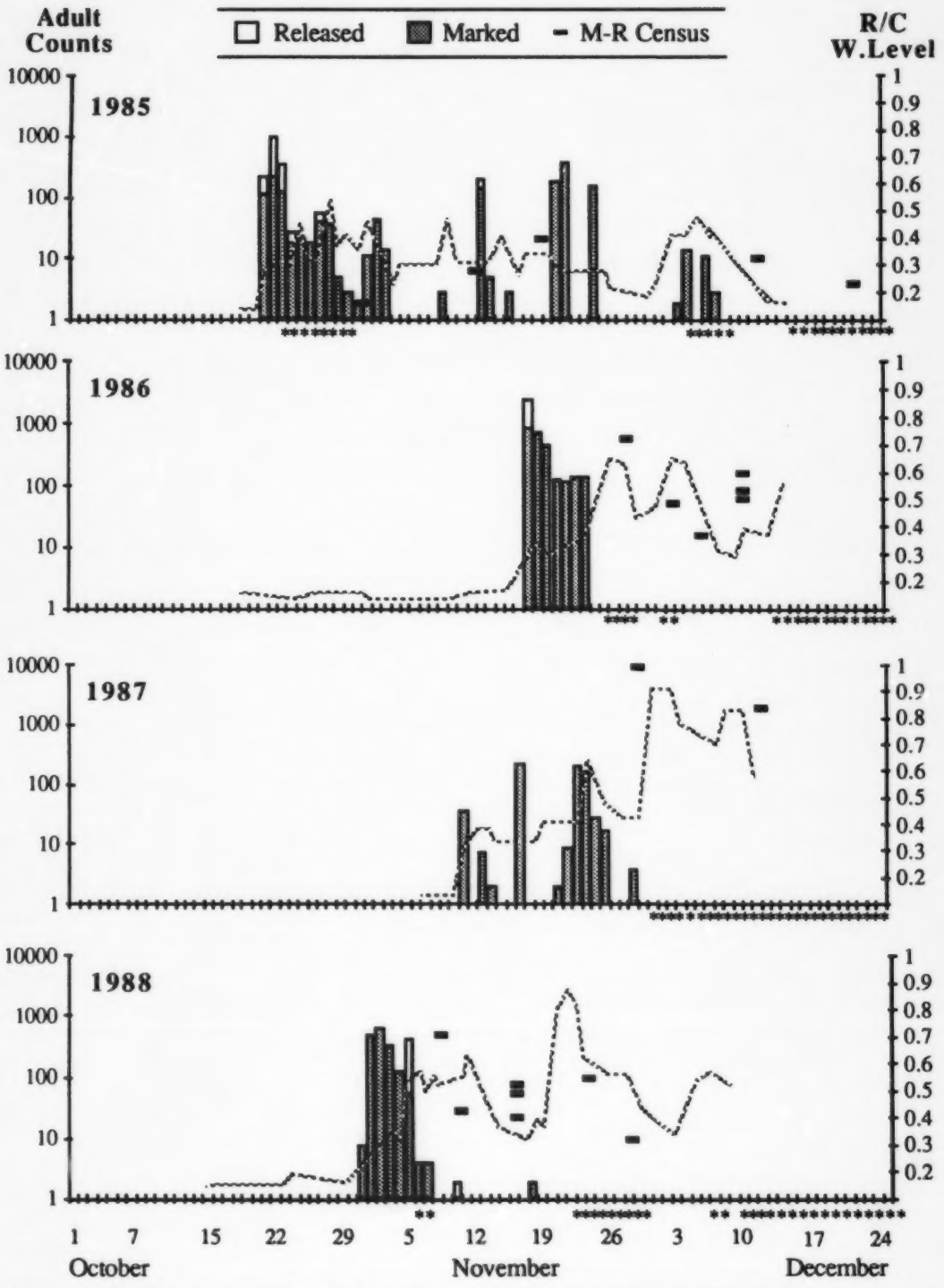

Fig. 4.1. Daily fence counts (vertical bars), water levels (dotted line), and distribution of stream survey samples (horizontal bars = R_i/C_i) for adult coho at Black Creek. Stars (*) indicate incomplete fence counts. Water levels correspond to scale units x 1.6 m.

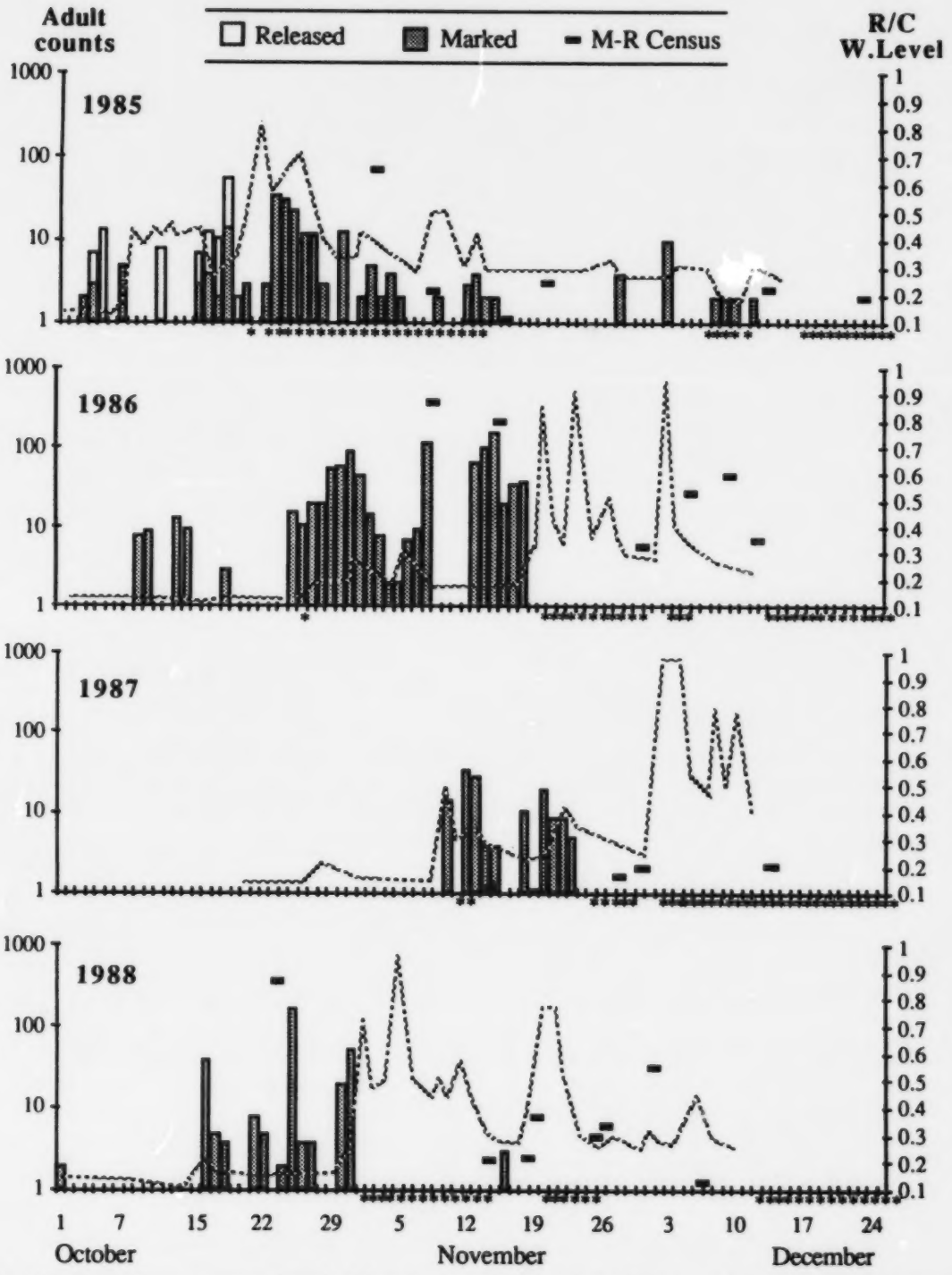

Fig. 4.2. Daily fence counts (vertical bars), water levels (dotted line), and distribution of stream survey samples (horizontal bars = R_i/C_i) for adult coho at Trent River. Stars (*) indicate incomplete fence counts. Water levels correspond to scale units x 2.0 m.

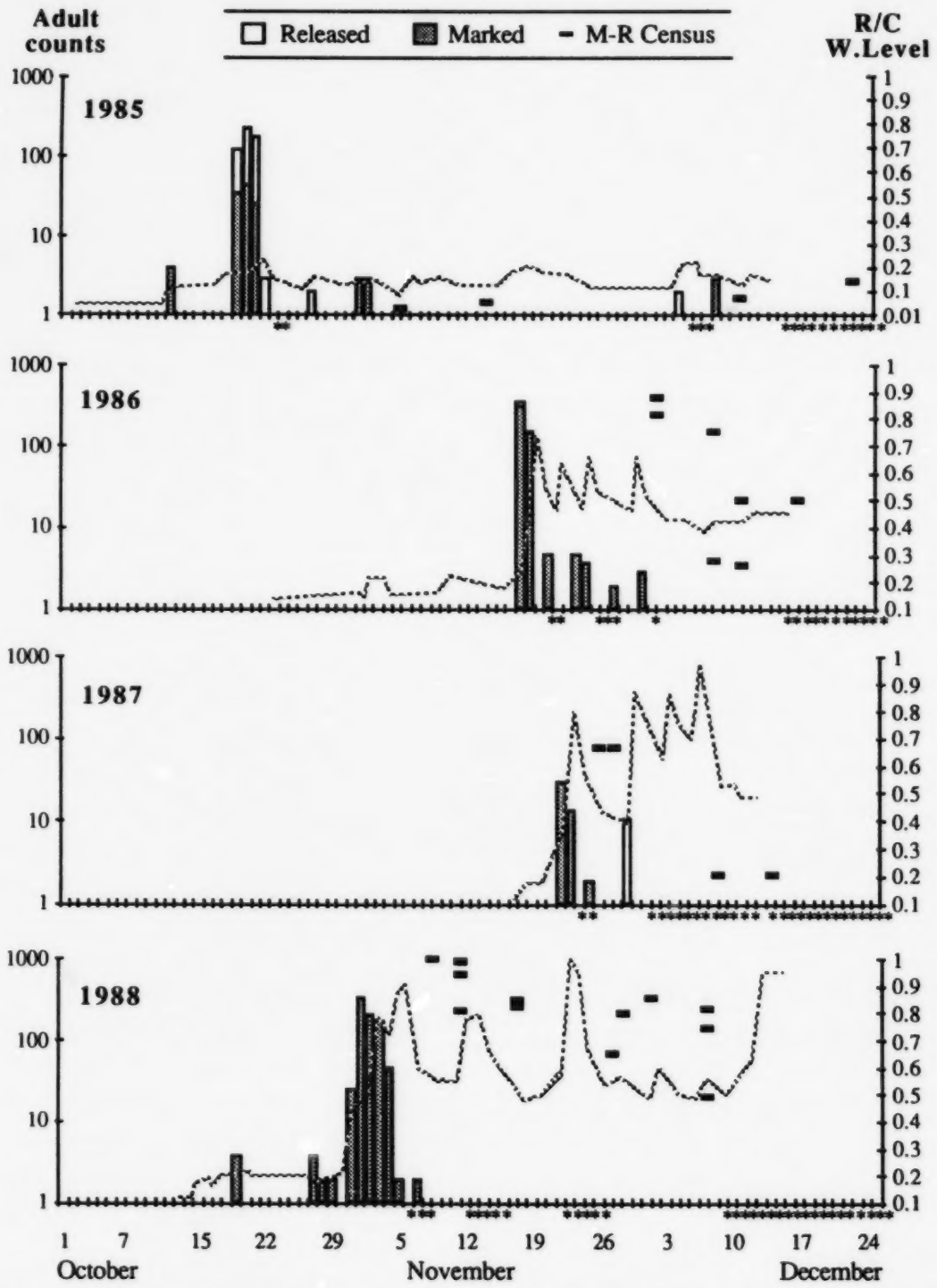

Fig. 4.3. Daily fence counts (vertical bars), water levels (dotted line), and distribution of stream survey samples (horizontal bars = R_t/C_t) for adult coho at French Creek. Stars (*) indicate incomplete fence counts. Water levels correspond to scale units x 0.8 m.

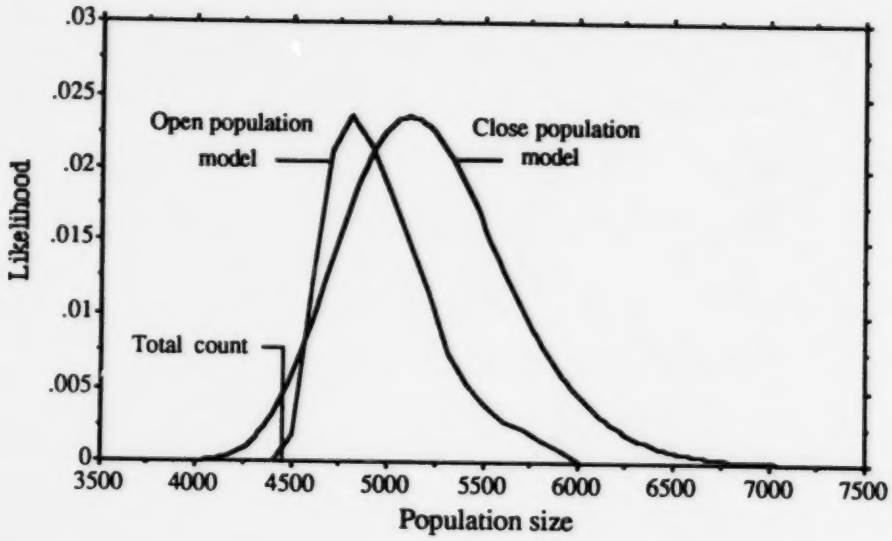

Figure 5.1. Comparison of likelihood curves generated by both mark-recapture models, using adult census data from Black Creek, 1986. The total count pointer indicates the lowest escapement level possible, which is given by the total fence count combined with the total number of unmarked fish recovered during stream surveys.

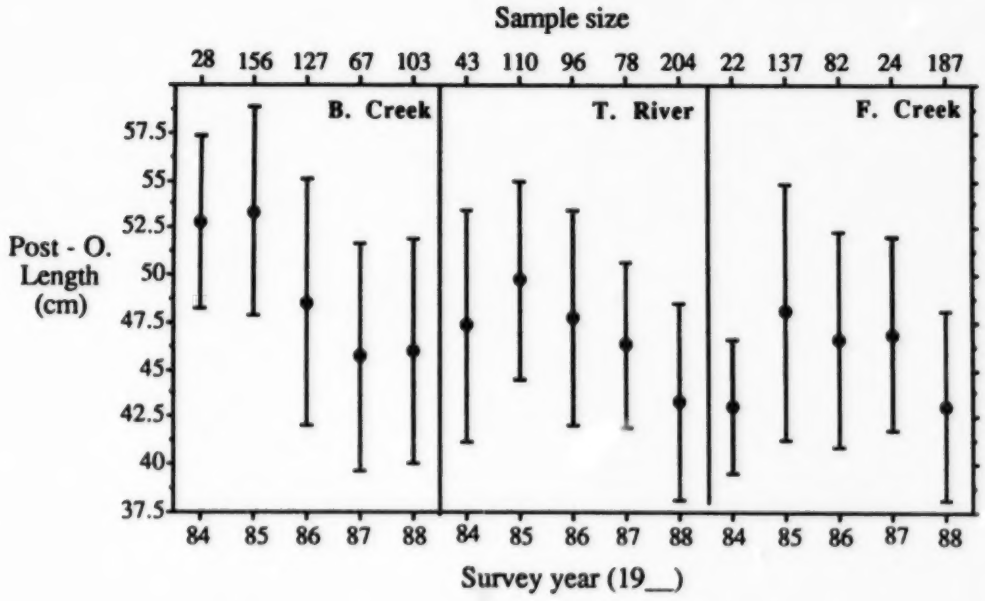

Figure 6.1. Post-orbital hypural length of adults sampled at Black Creek, Trent River and French Creek, 1984 to 1988. Each vertical bar consists of the mean length (mid dot) ± one standard deviation, and the corresponding sample size are given.

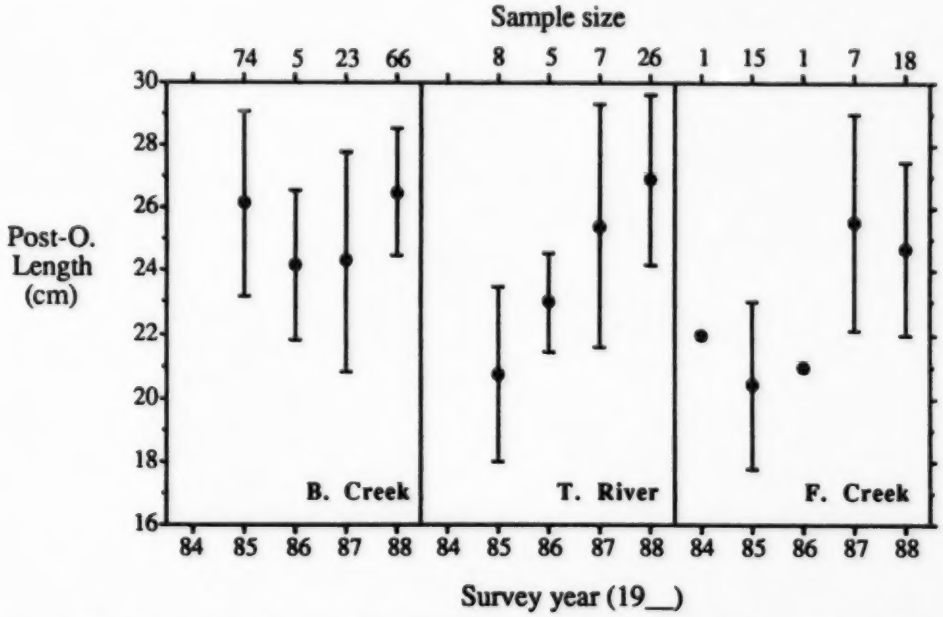

Figure 6.2. Post-orbital hypural length of jacks sampled at Black Creek, Trent River and French Creek, 1984 to 1988. Each vertical bar consists of the mean length (mid dot) ± one standard deviation, and the corresponding sample size are given.

BLACK CREEK JUVENILE TAGGING DATABASE (1985)

Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lampreys
dd-mmm	date	oper. (h)	eff. (%)	level (cm)	temp. (C.)	caught	tagged	no L.V	no R.V	trout	trout		
1-May	121	24		21	9	107	105	0	0	2	0	22	0
2-May	122	24		20	10	183	183	0	0	2	0	3	0
3-May	123	24		20	9	40	40	0	0	0	1		0
4-May	124	24		19	8	129	129	0	0	0	6		0
5-May	125	24		18	8	198	194	0	0	1	0		0
6-May	126	24		17	8	425	425	0	0	2	1		0
7-May	127	24		16	8	171	171	0	0	1	2		0
8-May	128	24		15	9	9	9	0	0	0	0		0
9-May	129	24		16	8	340	340	0	0	3	1		0
10-May	130	24		14	10	549	549	0	0	0	1		0
11-May	131	24		14	8	1469	1468	0	0	3	0		4
12-May	132	24		13	9	604	603	0	0	1	1		0
13-May	133	24		14	9	3486	3371	0	0	2	3		0
14-May	134	24		13	9	3000	2995	0	0	1	2	1	0
15-May	135	24		12	9	3706	2203	0	0	4	1	2	0
16-May	136	24		11	9	3526	3526	0	0	3	3	0	0
17-May	137	24		10	11	4133	3521	0	0	3	0	0	0
18-May	138	24		10	11	5913	611	0	0	2	3	1	0
19-May	139	24		9	12	8800	3290	0	0	8	4	3	1
20-May	140	24		9	13	2750	523	0	0	2	2		0
21-May	141	24		7	13	3080	0	0	0	3	1		0
22-May	142	24		7	13	2900	0	0	0	10	2		0
23-May	143	24		7	13	3280	0	0	0	2	1		0
24-May	144	24		6	14	1170	0	0	0	1	0		0
25-May	145	24		6	14	140	0	0	0	2	1	2	0
26-May	146	24		5	14	100	0	0	0	2	1	0	0
Tag Codes	23119	23120	23121		Total	50208	24256	0	0	60	37	34	5
Total tags	8066	8095	8095		% Total	100	48.3	0	0				
% Ret 24h	99.5	99.5	99.5		% Tagged	48.1							
Tags rel.	8026	8054	8054										

BLACK CREEK JUVENILE TAGGING DATABASE (1986)

Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lampreys
dd-mmm	date	oper. (h)	eff. (%)	level (cm)	temp. (C.)	caught	tagged	no L.V	no R.V	trout	trout		
15-Apr	105	24		4	8	0	0	0	0	0	0	18	0
16-Apr	106	24		5	8	4	0	0	0	0	3	17	0
17-Apr	107	19		14	8	0	0	0	0	0	0	8	0
18-Apr	108	24		12	8	2	0	0	0	1	0	27	2
19-Apr	109	24		10	9	5	0	0	0	0	0	24	1
20-Apr	110	24		9	9	16	0	0	0	0	4	21	0
21-Apr	111	24		7	9	14	0	0	0	0	1	20	0
22-Apr	112	24		5	9	4	0	0	0	0	2	27	0
23-Apr	113	24		2	9	18	0	0	0	1	1	18	0
24-Apr	114	24		0	9	6	0	0	0	0	0	43	1
25-Apr	115	24		13	7	34	0	0	0	1	4	27	1
26-Apr	116	24		14	8	7	0	0	0	0	0	18	2
27-Apr	117	24		17	8	6	0	0	0	1	0	23	0
28-Apr	118	24		16	8	17	0	0	0	0	0	27	1
29-Apr	119	24		17	8	25	0	0	0	1	2	30	0
30-Apr	120	24		15	8	55	0	0	0	3	1	7	0
1-May	121	24		18	9	76	0	0	0	3	2	21	1
2-May	122	24		18	9	37	0	0	0	0	2	15	0
3-May	123	24		22	9	111	0	0	0	4	9	30	0
4-May	124	24		23	9	89	0	0	0	0	1	13	1
5-May	125	24		17	9	60	0	0	0	0	2	15	0
6-May	126	24		21	9	32	0	0	0	2	4	9	0
7-May	127	24		22	11	27	24	0	0	1	1	8	0
8-May	128	24		28	10	205	200	0	0	5	9	15	0
9-May	129	24	80	24	12	100	100	0	0	4	7	8	1
10-May	130	24	80	26	12	487	475	0	0	2	0	21	0
11-May	131	24	80	23	11	186	186	0	0	0	1	11	0
12-May	132	24	80	24	10	502	498	0	0	2	1	11	0
13-May	133	24	80	25	10	520	514	2	0	0	0	9	1
14-May	134	24	80	24	9	578	568	0	0	0	1	20	3
15-May	135	24	80	22	9	800	800	0	0	3	1	8	0
16-May	136	24	80	22	10	859	828	0	0	0	0	8	0
17-May	137	24	80	21	10	1480	1440	1	0	0	0	3	0
18-May	138	24	80	21	10	2482	2381	0	0	0	0	0	0
19-May	139	24		22	11	1488	1418	1	0	3	0	6	1
20-May	140	24		20	11	2827	2658	2	0	8	7	23	0
21-May	141	24		19	11	1625	1527	0	0	0	0	7	0
22-May	142	24		18	9	1457	1375	0	0	1	0	16	0
23-May	143	24		17	10	2702	2491	1	0	2	1	0	0
24-May	144	24		22	10	3912	3653	0	0	30	38	5	2
25-May	145	24		32	12	1541	1445	1	0	9	22	28	3
26-May	146	24		36	12	1462	1280	0	1	7	9	10	0
27-May	147	24		32	13	563	516	0	0	0	1	29	0
28-May	148	24		34	14	3830	3577	1	0	0	1	24	0
29-May	149	24		27	14	2060	1131	1	0	2	0	34	0
30-May	150	24		24	15	1566	1366	0	0	1	1	15	0
31-May	151	24		22	15	2295	1549	0	0	2	1	66	0
1-Jun	152	24		15	16	735	0	0	0	0	1	21	0
2-Jun	153	24		10	15	207	0	0	0	0	0	7	0
3-Jun	154	24		14	14	595	0	0	0	0	2	2	0
4-Jun	155	24		11	14	503	0	0	0	0	1	3	0
Tag Codes	23841	23825	23823	23824	Total	38212	32000	10	1	99	144	858	21
Total tags	8000	8000	8000	8000	% Total	100	83.7	0	0				
% Ret 24h	98.9	98.9	98.9	98.9									
Tags Rel	7912	7912	7912	7912	% Tagged	82.8							

BLACK CREEK JUVENILE TAGGING DATABASE (1987)													
Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lampreys
dd-mmm	date	oper. (h)	eff. (%)	level (cm)	temp. (C.)	caught	tagged	no L.V	no R.V	trout	trout		
8-Apr	98	24		38	8	160	0	0	0	0	2	16	0
9-Apr	99	24		43	9	164	0	0	0	2	16	34	0
10-Apr	100	24		53	8	189	0	0	0	1	5	29	0
11-Apr	101	24		43	8	83	0	0	0	3	18	31	0
12-Apr	102	24		38	8	66	0	0	0	4	24	25	0
13-Apr	103	24		33	9	58	0	0	0	15	88	3	0
14-Apr	104	24		33	9	22	0	0	0	8	37	4	0
15-Apr	105	24		40	9	15	0	0	0	6	27	19	0
16-Apr	106	24		38	9	21	0	0	0	11	68	7	0
17-Apr	107	19		36	7	52	0	0	0	30	170	7	0
18-Apr	108	24		33	7	89	0	0	0	23	110	19	0
19-Apr	109	24		33	7	72	0	0	0	1	5	30	0
20-Apr	110	24		34	8	64	0	0	0	6	51	3	0
21-Apr	111	24		30	9	111	0	0	0	9	35	19	0
22-Apr	112	24		29	8	159	0	0	0	6	33	8	0
23-Apr	113	24		28	9	322	0	0	0	3	14	15	0
24-Apr	114	24		25	9	346	0	0	0	4	15	19	0
25-Apr	115	24		28	9	98	0	0	0	4	18	22	0
26-Apr	116	24		24	9	195	0	0	0	2	10	26	0
27-Apr	117	24		24	9	276	0	0	0	3	7	15	0
28-Apr	118	24		20	9	271	0	0	0	1	7	16	0
29-Apr	119	24		25	9	401	354	0	0	0	1	10	1
30-Apr	120	24		35	10	379	323	0	0	1	0	20	1
1-May	121	24		45	11	1070	910	0	0	10	5	16	1
2-May	122	24		55	11	1174	970	0	0	17	20	17	0
3-May	123	24		47	11	166	0	0	0	0	1	9	0
4-May	124	24		38	11	693	545	0	0	0	3	8	0
5-May	125	24		30	11	349	291	0	0	0	0	25	0
6-May	126	24		43	12	669	569	0	0	3	8	14	0
7-May	127	24		40	13	1670	1432	0	0	0	12	9	1
8-May	128	24		33	14	2916	2461	0	0	1	20	6	0
9-May	129	24	96	31	14	4470	1468	3	0	0	4	0	0
10-May	130	24	96	28	13	7391	4082	0	0	1	1	1	0
11-May	131	24	96	27	15	3620	2990	3	1	2	2	0	0
12-May	132	24	96	26	12	4775	3510	15	6	1	2	0	0
13-May	133	24	96	22	11	3225	1917	8	1	3	3	2	1
14-May	134	24	96	22	12	3740	3323	11	4	4	12	8	1
15-May	135	24	96	22	10	3218	1730	20	42	4	16	1	0
16-May	136	24		17	10	4523	4158	23	27	4	23	2	0
17-May	137	24		32	12	3301	2000	49	41	10	24	12	1
18-May	138	24		27	11	3521	2967	43	59	4	1	1	0
19-May	139	24		15	11	2155	0	35	30	9	4	8	0
20-May	140	24		12	11	1735	0	20	25	18	2	22	1
21-May	141	24		7	12	1422	0	25	29	28	2	32	1
22-May	142	24		7	12	996	0	20	22	17	4	11	0
23-May	143	24		5	12	497	0	8	10	2	0	4	0
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Tag Codes	82421	82422	82423	82424	Total	60909	36000	283	297	281	930	605	9
Total tags	9000	9000	9000	9000	% Total	100	59.1	0.5	0.5				
% Ret 24h	99	99	99	99									
Tags Rel.	8910	8910	8910	8910	% Tagged	58.5							
Notes:	81 adult cutthroat and 22 adult steelhead were captured and released												

FRENCH CREEK JUVENILE TAGGING DATABASE (1986)													
Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lampreys
dd-mmm	day	Oper (h)	Eff. (%)	Level	Temp.	Caught	Tagged	no L.V	no R.V	Trout	Trout		
18-Apr	108	24		19	7	3	0	0	0	0	1	0	0
19-Apr	109	24		21	9	6	0	0	0	1	8	0	0
20-Apr	110	24		18	10	3	0	0	0	0	0	0	0
21-Apr	111	24		18	10	11	0	7	0	3	30	0	0
22-Apr	112	24		20	10	3	0	1	0	0	3	0	0
23-Apr	113	24		25	10	1	0	1	0	0	2	0	0
24-Apr	114	24		25	7	36	0	25	0	3	12	0	0
25-Apr	115	24		20	8	9	0	4	0	0	11	0	0
26-Apr	116	24		22	8	20	0	10	0	2	16	0	0
27-Apr	117	24		24	8	42	0	19	0	0	35	0	0
28-Apr	118	24		20	7	64	0	17	0	3	61	0	0
29-Apr	119	24		22	6	14	0	8	0	3	4	0	0
30-Apr	120	24		21	6	35	0	15	0	5	38	0	0
1-May	121	24		24	7	73	0	28	0	9	41	0	0
2-May	122	24		27	8	137	0	47	0	8	97	0	0
3-May	123	24		31	8	151	0	41	0	5	116	0	0
4-May	124	24		40	9	315	0	62	0	21	125	15	0
5-May	125	24		41	8	171	0	28	0	17	82	10	0
6-May	126	24		38	8	112	0	23	0	3	75	0	0
7-May	127	24		37	9	240	0	45	0	19	68	5	0
8-May	128	24		35	11	174	0	39	0	20	72	3	0
9-May	129	24		33	10	181	128	38	0	6	79	2	0
10-May	130	24		36	10	145	125	18	0	10	57	3	0
11-May	131	24		35	11	604	506	93	0	23	113	0	0
12-May	132	24		35	10	301	278	23	0	13	88	5	0
13-May	133	24		49	8	614	590	14	0	21	129	10	0
14-May	134	24		45	7	1197	1086	31	0	31	52	6	0
15-May	135	24		46	8	700	700	19	0	20	80	6	0
16-May	136	24	100	45	8	411	393	16	0	9	52	8	0
17-May	137	24	100	43	8	289	277	9	0	7	42	0	0
18-May	138	24	100	46	10	541	531	12	0	9	39	5	0
19-May	139	24	100	47	10	647	625	10	0	15	46	15	0
20-May	140	24	100	52	9	1054	1029	10	0	24	61	4	0
21-May	141	24	100	52	8	1113	1084	16	0	15	29	3	0
22-May	142	24	100	51	8	673	651	2	0	7	50	3	0
23-May	143	24	100	48	8	704	693	4	0	6	29	2	0
24-May	144	24	100	47	11	930	906	4	0	4	30	2	0
25-May	145	24	100	52	11	1272	1240	5	0	7	22	4	0
26-May	146	24	100	57	11	1836	1810	8	0	22	17	8	0
27-May	147	24	100	47	12	1901	1850	2	0	28	38	5	0
28-May	148	24	100	47	11	564	547	1	0	3	3	5	1
29-May	149	24	100	43	14	1304	1271	2	0	15	22	10	0
30-May	150	24	100	42	12	1036	1008	1	0	13	7	13	3
31-May	151	24	100	42	13	1223	1156	0	0	26	15	0	1
1-Jun	152	24	100	39	13	964	849	0	0	28	8	6	1
2-Jun	153	24	100	37	14	1343	1322	1	0	17	11	1	0
3-Jun	154	24		34	13	555	549	0	0	15	2	9	0
4-Jun	155	24		30	13	1413	1212	0	0	28	14	1	0
5-Jun	156	24		30	14	1048	923	0	0	26	5	3	0
6-Jun	157	24		29	14	773	661	0	0	25	2	2	2
7-Jun	158	24		27	13	528	0	1	0	10	0	2	1
8-Jun	159	24		25	13	484	0	0	0	8	1	4	0
9-Jun	160	24		23	13	379	0	0	0	8	0	3	0
10-Jun	161	24		21	13	335	0	0	0	11	0	4	3
11-Jun	162	24		19	14	345	0	0	0	6	2	6	1
12-Jun	163	24		18	13	128	0	0	0	6	0	5	2
Tag Codes	23832	23831	23837		Total	29155	24000	760	0	644	2042	198	15
Total tags	8000	8000	8000		% Total	100	82.3	2.6	0				
% Ret.	99.33	99.33	99.33										
Tags rel.	7946	7946	7946		% Tagged	81.8							

FRENCH CREEK JUVENILE TAGGING DATABASE (1987)

Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lampreys
dd-mmm	Day	Oper. (h)	Eff. (%)	Level	Temp.	Caught	Tagged	no L.V	no R.V.	Trout	Trout		
11-Apr	101	24		24	8	18	0	9	22	25	0		
12-Apr	102	24		21	7	8	0	20	16	19	0		
13-Apr	103	24		19	8	15	0	3	12	11	0		
14-Apr	104	24		27	8	8	0	5	12	23	0		
15-Apr	105	24		29	8	25	0	9	45	26	0		
16-Apr	106	24		36	8	63	0	32	0	11	28	43	0
17-Apr	107	12		33	6	0	0	0	0	0	0	0	0
18-Apr	108	24		28	6	73	0	21	0	9	19	29	1
19-Apr	109	24		24	6	26	0	10	0	2	25	13	0
20-Apr	110	24		22	6	28	0	6	1	4	12	6	0
21-Apr	111	24		21	7	29	0	7	1	6	13	9	0
22-Apr	112	24		20	6	26	0	6	1	3	22	12	0
23-Apr	113	24		20	8	37	0	10	0	6	37	4	2
24-Apr	114	24		13	8	34	0	12	4	17	36	21	0
25-Apr	115	24		17	7	72	0	17	2	26	83	11	0
26-Apr	116	24		15	7	58	0	21	8	8	41	9	0
27-Apr	117	24		15	8	81	0	21	8	9	56	14	0
28-Apr	118	24		15	10	112	0	30	3	41	88	13	0
29-Apr	119	24		15	11	163	120	46	10	35	47	8	0
30-Apr	120	24		14	12	198	170	46	16	43	62	14	0
1-May	121	24		14	11	357	350	43	16	31	40	13	1
2-May	122	24		15	9	189	171	47	13	16	102	14	1
3-May	123	24		17	10	118	105	29	7	2	84	3	1
4-May	124	24		16	10	258	237	23	4	5	88	6	0
5-May	125	24		16	10	755	703	65	15	17	140	3	0
6-May	126	24		17	10	395	362	20	2	8	69	6	0
7-May	127	24		15	11	532	500	29	6	5	90	7	0
8-May	128	24		14	12	654	614	27	8	29	89	5	1
9-May	129	24		11	12	799	776	23	2	10	47	5	0
10-May	130	24		11	12	1040	1040	22	4	15	135	9	2
11-May	131	24		10	13	993	887	8	0	6	68	2	1
12-May	132	24		13	11	1409	1282	10	1	19	55	2	0
13-May	133	24		10	10	1459	1250	8	4	17	48	1	0
14-May	134	24		10	11	977	896	7	2	13	115	2	0
15-May	135	24		10	10	2025	1788	18	1	7	75	1	0
16-May	136	24		9	11	1828	1475	5	2	15	81	1	5
17-May	137	24		8	11	1349	1017	5	0	4	14	0	0
18-May	138	24		8	11	1960	1687	9	1	11	56	1	0
19-May	139	24		8	10	1636	1317	14	0	17	70	4	0
20-May	140	24		7	10	1727	1358	4	3	39	37	1	0
21-May	141	24	100	7	11	1456	1245	3	1	26	53	2	0
22-May	142	24	100	7	11	1231	1049	2	0	16	36	5	1
23-May	143	24	100	7	12	1413	1224	0	0	32	21	2	0
24-May	144	24	100	6	12	1169	1035	2	0	15	38	1	0
25-May	145	24	100	5	12	971	852	2	0	11	17	2	0
26-May	146	24	100	4	12	633	572	1	0	8	16	1	0
27-May	147	24	100	3	13	1156	518	0	0	0	4	1	4
28-May	148	24	100	3	12	489	0	0	0	1	10	1	0
29-May	149	24	100	3	11	785	0	3	0	2	5	2	2
30-May	150	24		4	12	185	0	0	0	1	5	1	1
31-May	151	24		15	12	1180	0	3	1	30	132	3	2
1-Jun	152	24		14	11	698	0	11	2	26	44	2	0
2-Jun	153	24		12	11	418	0	3	0	2	12	1	0
3-Jun	154	24		8	12	268	0	1	0	4	9	1	1
4-Jun	155	24		5	12	184	0	0	0	4	7	1	1
5-Jun	156	24		3	11	147	0	0	0	0	3	1	1
Tag Code	82425	82426	82427		Total	33917	24600	778	256	788	2484	319	28
Total tags	8200	8200	8200		% Total	100	72.5	2.3	0.8				
% Ret.	99	99	99										
Tags rel.	8118	8118	8118		% Tagged	71.8							

TRENT RIVER JUVENILE TAGGING DATABASE (1985)

Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lampreys
dd-mmm	Day	Oper. (h)	Eff. (%)	Level (cm)	Temp. (C.)	Caught	Tagged	w/out L.V	w/out R.V	Trout	Trout		
1-May	121	15		45	6	4	0	0	0	0	4	35	0
2-May	122	15		40	6	9	0	0	0	0	11	50	0
3-May	123	15		38	5	4	0	0	0	0	25	99	0
4-May	124	15		40	4	1	0	0	0	0	0	0	0
5-May	125	24		30	5	3	0	0	0	0	2	18	0
6-May	126	24		35	6	3	0	0	0	0	2	23	0
7-May	127	24		35	5	4	0	0	0	0	5	22	0
8-May	128	15		33	5	0	0	0	0	0	0	14	0
9-May	129	15		28	5	0	0	0	0	0	0	0	0
10-May	130	15		27	7	0	0	0	0	0	0	24	0
11-May	131	15		24	6	1	0	0	0	0	0	0	0
12-May	132	15		19	5	0	0	0	0	0	0	0	0
13-May	133	15		18	6	0	0	0	0	0	0	0	0
14-May	134	15		31	6	0	0	0	0	0	0	0	0
15-May	135	15		32	7	0	0	0	0	0	0	0	0
16-May	136	24		36	8	32	0	0	0	0	5	16	0
17-May	137	16		35	8	0	0	0	0	0	6	0	0
18-May	138	16		45	8	0	0	0	0	0	0	15	0
19-May	139	24		40	9	1	0	0	0	0	2	47	0
20-May	140	24		32	9	0	0	0	0	0	0	14	0
21-May	141	16		31	9	0	0	0	0	0	0	0	0
22-May	142	16		31	9	906	73	0	0	0	12	26	0
23-May	143	22		30	11	821	60	0	0	0	3	84	0
24-May	144	22		31	11	1004	168	0	0	0	11	57	0
25-May	145	22		31	11	1129	358	0	0	0	75	59	0
26-May	146	24		23	11	647	100	0	0	0	0	0	0
27-May	147	24		20	12	500	500	0	0	0	0	10	0
28-May	148	24		18	12	400	398	0	0	0	17	20	0
29-May	149	24		17	12	595	595	0	0	0	10	9	0
30-May	150	24		17	11	771	768	0	0	0	9	1	0
31-May	151	24		15	12	662	662	0	0	0	6	1	0
1-Jun	152	24		14	12	542	542	0	0	0	7	12	0
2-Jun	153	24		15	13	615	614	0	0	0	11	25	0
3-Jun	154	24		11	13	615	614	0	0	0	7	30	0
4-Jun	155	24		13	13	562	552	0	0	0	1	0	0
5-Jun	156	24		15	13	741	723	0	0	0	10	33	0
6-Jun	157	24		10	12	202	202	0	0	0	0	0	5
7-Jun	158	24		8	12	267	267	0	0	0	2	18	0
8-Jun	159	24		8	11	554	542	0	0	0	5	26	0
9-Jun	160	24		6	11	223	223	0	0	0	1	31	0
10-Jun	161	24		3	12	269	269	0	0	0	3	28	0
11-Jun	162	24		3	13	318	318	0	0	0	89	14	0
12-Jun	163	24		3	13	185	185	0	0	0	26	19	0
13-Jun	164	24		3	13	252	252	0	0	0	30	0	0
14-Jun	165	24		3	13	110	0	0	0	0	0	0	0
Tag Codes	23122	23123				Total	12952	8985	0	0	0	397	880	5
otal Tagge	4473	4512				% Total	100	69.4	0	0	0			
% Ret. 24h	99.9	99.9												
ags released	4468	4507				% Tagged	69.3							

TRENT RIVER JUVENILE TAGGING DATABASE (1986)

Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lamprey
dd/m	Day	Oper. (h)	Eff. (%)	Level (cm)	Temp. (C.)	Caught	Tagged	w/out L.V	w/out R.V	Trout	Trout		
25-Apr	115	24		25	5	3	0	1	0	0	6	14	0
26-Apr	116	24		27	6	12	0	1	0	0	13	15	0
27-Apr	117	24		36	9	33	0	2	0	0	33	15	0
28-Apr	118	24		30	7	15	0	1	0	0	27	37	0
29-Apr	119	24		28	5	7	0	1	0	0	11	21	0
30-Apr	120	24		25	4	16	0	1	0	0	13	24	0
01-May	121	24		23	6	31	0	3	0	0	22	11	0
02-May	122	24		31	8	38	0	4	0	0	51	31	0
03-May	123	24		29	7	78	0	8	2	0	78	66	0
04-May	124	24		29	6	44	0	4	0	1	26	39	0
05-May	125	24		30	7	24	0	2	0	0	23	36	0
06-May	126	24		29	6	18	0	1	0	0	21	35	0
07-May	127	24		26	9	115	111	10	9	0	49	61	0
08-May	128	24		26	8	59	57	14	12	0	32	60	0
09-May	129	24		24	9	35	35	5	0	0	36	22	0
10-May	130	24		22	8	130	130	20	3	1	82	43	0
11-May	131	24		21	9	99	90	15	2	2	37	30	0
12-May	132	24		20	7	93	93	10	1	0	51	32	1
13-May	133	24		39	6	315	315	30	9	0	82	37	1
14-May	134	24		31	6	307	307	31	9	0	18	0	0
15-May	135	24		28	6	157	150	40	2	0	14	11	0
16-May	136	24		25	7	340	340	80	4	0	15	17	0
17-May	137	24	100	23	8	100	100	40	2	0	2	12	0
18-May	138	24	100	24	9	300	300	120	8	1	8	10	0
19-May	139	24	100	25	9	676	665	248	16	0	15	10	1
20-May	140	24	100	25	9	924	915	225	25	0	12	23	0
21-May	141	24	100	22	8	622	617	166	11	0	30	13	0
22-May	142	24	100	21	7	319	309	88	12	0	21	9	0
23-May	143	24	100	19	8	168	164	63	6	0	12	10	0
24-May	144	16		20	9	150	114	43	5	0	6	12	0
25-May	145	0		80	9	223	200	70	10	0	9	12	0
26-May	146	0		60	9	300	300	70	10	0	10	20	0
27-May	147	0		35	9	300	300	70	10	1	10	20	0
28-May	148	0	15	30	10	300	300	70	10	1	10	20	0
29-May	149	10	15	28	12	125	120	35	7	0	19	13	0
30-May	150	24		24	12	127	117	38	8	0	19	13	0
31-May	151	24		24	13	678	665	295	31	0	0	10	1
01-Jun	152	24		19	13	382	335	170	10	0	4	23	1
02-Jun	153	24		17	12	382	336	173	10	0	5	23	0
03-Jun	154	24		15	13	791	732	361	25	0	27	16	0
04-Jun	155	24		14	14	359	348	155	14	0	24	3	1
05-Jun	156	24		14	14	586	562	181	25	0	12	15	0
06-Jun	157	24		12	14	248	223	101	10	0	13	12	0
07-Jun	158	24		12	14	208	189	76	7	0	9	1	0
08-Jun	159	24		13	13	243	220	70	16	1	54	4	1
09-Jun	160	24		11	13	380	343	115	29	0	41	0	0
10-Jun	161	24		11	14	102	92	35	9	0	36	10	0
11-Jun	162	24		10	14	132	110	38	8	0	16	7	1
12-Jun	163	24		7	14	67	58	22	5	0	26	0	0
13-Jun	164	24		6	15	40	35	14	2	0	11	0	0
14-Jun	165	24		5	16	32	30	16	3	0	6	0	0
15-Jun	166	24		5	16	33	29	16	3	0	6	0	0
16-Jun	167	24		14	16	65	57	29	2	0	38	0	0
17-Jun	168	24		11	14	38	32	17	2	0	18	3	0
18-Jun	169	24		15	13	19	19	12	2	0	5	3	0
Tag Codes	23827	23826	23833		Total	11388	10564	3526	406	8	1274	984	8
otal Tagge	3450	3450	3664		% Total	100	92.8	31	3.6				
b Ret. (24h	99.7	99.7	99.7										
ags release	3439	3439	3653		% Tagged	92.5							

TRENT RIVER JUVENILE TAGGING DATABASE (1987)

Date	Calendar	Fence	Trapping	Water	Water	Coho	Coho	Coho	Coho	Cutthroat	Rainbow	Sculpins	Lampreys
dd-mmm	date	Oper. (h)	Eff. (%)	Level (cm)	Temp. (C.)	caught	tagged	no L.V	no R.V	trout	trout		
25-Apr	115	24		15	9	6	0	0	0	1	27	32	0
26-Apr	116	24		15	9	5	0	0	0	0	30	42	0
27-Apr	117	24		15	9	10	0	0	0	0	32	40	0
28-Apr	118	24		25	10	26	0	1	0	0	76	52	0
29-Apr	119	24		26	10	62	0	2	1	1	57	48	0
30-Apr	120	24		25	10	27	0	0	0	0	48	44	0
1-May	121	24		28	9	42	0	2	0	3	56	30	0
2-May	122	24		25	8	18	0	1	0	2	17	15	1
3-May	123	22		23	9	21	0	1	0	2	9	11	0
4-May	124	5		53	8	751	472	16	6	1	119	47	0
5-May	125	18		38	8	0	0	0	0	0	0	0	0
6-May	126	24		32	9	158	165	4	1	0	30	10	1
7-May	127	24		30	10	344	300	10	2	1	65	24	0
8-May	128	24		26	10	522	448	34	6	0	62	34	0
9-May	129	24		26	10	364	335	58	3	0	64	35	1
10-May	130	24		24	11	382	342	107	4	0	75	24	0
11-May	131	24		20	12	307	266	160	9	1	50	23	0
12-May	132	24		23	10	1668	1607	524	9	0	56	0	0
13-May	133	24		18	10	604	583	192	2	0	19	0	0
14-May	134	24		16	9	689	592	255	7	1	29	14	0
15-May	135	24	92	16	9	1064	875	337	10	0	34	28	0
16-May	136	24	92	13	9	856	772	283	9	1	43	16	0
17-May	137	24	92	11	10	680	615	255	7	0	72	13	0
18-May	138	24	92	11	9	398	382	156	8	0	53	5	0
19-May	139	24	92	8	10	492	459	100	3	0	71	2	1
20-May	140	24	92	6	10	726	658	222	32	0	78	13	0
21-May	141	24	92	5	11	550	509	192	21	1	103	18	0
22-May	142	24	92	7	11	945	891	347	37	2	120	9	0
23-May	143	24	92	8	11	1084	1032	369	39	0	78	6	0
24-May	144	24	92	7	12	611	594	108	1	2	66	1	0
25-May	145	24	92	8	13	553	536	88	4	0	63	3	0
26-May	146	24	92	7	13	816	780	73	2	2	98	2	0
27-May	147	24	92	7	14	480	459	141	13	3	38	2	0
28-May	148	24	92	7	13	367	336	108	15	0	16	4	0
29-May	149	24	92	8	13	450	411	134	8	6	37	3	0
30-May	150	24	92	45	13	977	977	134	4	1	48	0	0
31-May	151	2		55	10	0	0	0	0	0	0	0	0
1-Jun	152	2		34	10	0	0	0	0	0	0	0	0
2-Jun	153	24		22	10	184	150	70	6	1	0	4	0
3-Jun	154	24		19	10	50	50	18	3	1	0	1	0
4-Jun	155	24		18	13	99	88	39	1	0	27	6	0
5-Jun	156	24		15	13	84	68	42	0	2	14	3	0
6-Jun	157	24		14	12	63	50	30	0	0	10	4	0
7-Jun	158	24		10	12	50	50	21	0	0	10	3	0
8-Jun	159	24		8	15	50	46	12	0	0	4	4	0
Tag Codes	24127	24128	24129		Total	17635	15898	4646	273	35	2004	675	4
Tot. Tagged	5043	5100	5706		% Total	100	90.2	26.3	1.5				
% Ret. 24	99	99	99										
Tags rel.	4993	5049	5649		% Tagged	89							

Notes: 24 adult steelhead were captured and released

1985 Black Creek Escapement Database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chum
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	6	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	7	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24	8	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24	8	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Oct	292	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24	10	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24	9	29	20	217	217	115	0	0	0	142	123	0	19	0	0	0
22-Oct	295	10	9	32	60	1011	1011	231	0	0	0	73	45	0	28	0	0	0
23-Oct	296	12	8	40	40	353	353	125	0	0	0	15	3	3	12	0	0	0
24-Oct	297	10	9	38	11	27	27	18	0	0	0	0	0	0	0	0	0	0
25-Oct	298	12	8	65	11	22	22	22	0	0	0	0	0	0	0	0	0	0
26-Oct	299	11	8	38	13	19	19	19	0	0	0	6	5	3	1	0	0	0
27-Oct	300	11	8	35	20	58	58	42	0	0	0	1	0	0	1	0	0	0
28-Oct	301	12	7	75	50	38	38	38	0	0	0	0	0	0	0	0	0	0
29-Oct	302	11	8	37	40	5	5	5	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24	7	45	30	3	3	3	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24	7	37	25	2	2	2	0	0	0	0	0	0	0	0	0	0
1-Nov	305	24	7	60	60	11	11	11	0	0	0	0	0	0	0	0	0	0
2-Nov	306	24	7	40	60	44	44	43	0	0	0	0	0	0	0	0	0	0
3-Nov	307	24	7	38	60	14	14	14	0	0	0	0	0	0	0	0	0	0
4-Nov	308	24	7	15	60	1	1	1	0	0	0	0	0	0	0	0	0	0
5-Nov	309	24	6	30	32	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	24	6	30	40	1	1	1	0	0	0	0	0	0	0	0	0	0
7-Nov	311	24	6	30	40	1	1	1	0	0	0	0	0	0	0	0	0	0
8-Nov	312	24	5	30	36	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24	4	35	18	3	3	3	0	0	0	1	1	1	0	0	0	0
10-Nov	314	24	3	65	20	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	24	3	30	16	0	0	0	0	0	0	1	1	1	0	0	0	0
12-Nov	316	24	2	30	11	0	0	0	0	0	0	1	1	1	0	0	0	0
13-Nov	317	24	3	32	27	213	206	152	0	0	0	0	0	0	0	0	0	0
14-Nov	318	24	3	32	19	6	5	5	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	4	45	40	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24	3	52	34	3	3	3	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24	2	30	60	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24	2	45	42	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	323	24	1	45	45	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Nov	324	24	1	45	45	0	0	0	0	0	0	2	1	1	1	0	0	0
21-Nov	325	24	0	30	34	203	193	193	0	0	0	10	7	7	3	0	0	0
22-Nov	326	24	0	30	34	413	396	396	2	0	0	0	0	0	0	0	0	0
23-Nov	327	24	0	30	33	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	24	0	30	20	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	24	0	30	20	172	168	168	0	0	0	6	6	6	0	0	0	0
26-Nov	330	24	0	30	20	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	24	0	15	20	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	0	15	20	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	0	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	0	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	24	1	8	20	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	24	0	8	20	19	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	24	1	15	20	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	12	1	60	20	2	2	2	0	0	0	0	0	0	0	0	0	0
5-Dec	339	12	1	60	20	15	15	15	0	0	0	0	0	0	0	0	0	0
6-Dec	340	10	1	65	20	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	10	2	75	60	12	11	11	0	0	0	1	1	1	0	0	0	0
8-Dec	342	10	1	60	60	3	3	3	0	0	0	0	0	0	0	0	0	0
9-Dec	343	24	0	50	60	1	1	1	0	0	0	0	0	0	0	0	0	0
10-Dec	344	24	1	45	60	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	24	1	35	50	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Dec	346	24	1	30	50	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Dec	347	24	1	28	40	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Dec	348	9	1	15	40	0	0	0	0	0	0	0	0	0	0	0	0	0
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Total						2892	2833	1643	2	0	0	259	194	24	65	0	0	0
% Total							0.9796	0.56812	0.00069	0	0		0.74903	0.09266	0.25097	0	0	

1986 Black Creek Escapement Database

Date	Calendar	Fence	Temp	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chum
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24	12	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24	12	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	12	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24	8	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24	7	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24	7	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24	5	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	5	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	5	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	6	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	7	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24	8	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Oct	292	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Oct	296	24	8	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	8	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24	10	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24	12	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	300	24	11	4	10	2	0	0	0	0	0	1	0	0	0	0	0	0
28-Oct	301	24	10	4	10	4	0	0	0	0	0	1	0	0	0	0	0	0
29-Oct	302	24	9	3	10	3	0	0	1	0	0	0	0	0	0	0	0	0
30-Oct	303	24	11	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24	9	5	10	3	0	0	1	0	0	0	0	0	0	0	0	0
1-Nov	305	24	10	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Nov	306	24	9	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	307	24	9	5	10	2	0	0	0	0	0	0	0	0	0	0	0	0
4-Nov	308	24	9	5	10	1	0	0	1	0	0	0	0	0	0	0	0	0
5-Nov	309	24	7	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	24	8	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Nov	311	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Nov	312	24	5	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24	4	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	24	4	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	24	5	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	24	7	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	317	24	7	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	318	24	7	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	7	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24	7	10	20	7	0	0	1	0	0	1	0	0	1	0	0	0
17-Nov	321	24	5	11	30	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24	6	31	58	2565	2565	895	445	0	0	172	172	80	102	0	0	0
19-Nov	323	24	7	41	80	796	796	795	124	0	0	8	8	8	3	0	0	0
20-Nov	324	24	7	36	80	484	484	479	92	0	0	3	3	3	1	0	0	0
21-Nov	325	24	6	43	67	131	131	131	24	0	0	2	2	2	0	0	0	0
22-Nov	326	24	6	43	67	125	125	125	23	0	0	1	1	1	0	0	0	0
23-Nov	327	24	6	47	67	139	139	139	21	0	0	1	1	1	0	0	0	0
24-Nov	328	24	6	52	67	146	146	146	22	0	0	1	1	1	0	0	0	0
25-Nov	329	12	6	73	80	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	0	5	98	200	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	0	5	91	175	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	12	4	78	175	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	4	57	70	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	5	67	80	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	2	6	93	175	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	14	3	89	111	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	24	2	68	111	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	24	2	53	60	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	24	2	45	50	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	24	2	38	50	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	24	3	33	50	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	24	3	58	50	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	24	1	55	50	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	24	2	54	45	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	24	2	54	45	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Dec	346	24	2	83	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						4408	4386	2710	755	0	0	191	188	96	107	0	0	0
% Total							0.99501	0.61479	0.17128	0	0		0.98429	0.50262	0.56021	0	0	

1987 Black Creek Escapement Database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chum
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24				0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24				0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24				0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24				0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24				0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24				0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24				0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24				0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24				0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24				0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24				0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24				0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24				0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24				0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24				0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24				0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24				0	0	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24				0	0	0	0	0	0	0	0	0	0	0	0	0
19-Oct	292	24				0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24				0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24				0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	24				0	0	0	0	0	0	0	0	0	0	0	0	0
23-Oct	296	24				0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24				0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24				0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24				0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	300	24				0	0	0	0	0	0	0	0	0	0	0	0	0
28-Oct	301	24				0	0	0	0	0	0	0	0	0	0	0	0	0
29-Oct	302	24				0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24				0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24				0	0	0	0	0	0	0	0	0	0	0	0	0
1-Nov	305	24				0	0	0	0	0	0	0	0	0	0	0	0	0
2-Nov	306	24				0	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	307	24				0	0	0	0	0	0	0	0	0	0	0	0	0
4-Nov	308	24				0	0	0	0	0	0	0	0	0	0	0	0	0
5-Nov	309	24				0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	24				0	0	0	0	0	0	0	0	0	0	0	0	0
7-Nov	311	24				0	0	0	0	0	0	0	0	0	0	0	0	0
8-Nov	312	24				0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24		2	20	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	24		2	20	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	24	11	35	20	38	37	37	26	0	0	172	171	159	92	2	0	0
12-Nov	316	24	10	45	20	0	0	0	0	0	0	31	31	28	10	0	0	0
13-Nov	317	24	10	45	20	27	8	8	21	0	0	13	13	13	7	0	0	0
14-Nov	318	24	6	50	25	5	2	2	5	0	0	4	4	4	0	0	0	0
15-Nov	319	24	7	45	20	0	0	0	0	0	0	1	1	1	0	0	0	0
16-Nov	320	24	6	45	20	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24	4	45	20	240	238	238	174	1	1	186	185	185	116	1	0	0
18-Nov	322	24	5	45	20	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	323	24	6	53	20	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Nov	324	24	6	53	20	1	0	0	1	0	0	0	0	0	0	0	0	0
21-Nov	325	24	6	53	20	4	2	2	3	0	0	3	2	2	2	0	0	0
22-Nov	326	24	7	55	25	9	9	9	6	0	0	11	11	11	8	0	0	0
23-Nov	327	24	6	58	50	208	205	205	153	0	0	83	83	83	55	0	0	0
24-Nov	328	24	8	93	150	162	161	160	105	0	0	24	24	24	13	0	0	0
25-Nov	329	24	6	78	99	31	30	30	26	0	0	0	0	0	0	0	0	0
26-Nov	330	24	6	70	75	18	18	18	10	0	0	0	0	0	0	0	0	0
27-Nov	331	24	7	70	75	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	6	60	100	1	0	0	1	0	0	0	0	0	0	0	0	0
29-Nov	333	24	5	60	100	6	4	4	3	0	0	0	0	0	0	0	0	0
30-Nov	334	24	5	60	100	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	4	6	150	250	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	0	6	150	250	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	0	6	130	200	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	0	6	125	200	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	0	5	125	200	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	0	6	120	150	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	0	6	112	150	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	0	6	114	150	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	0	7	140	200	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	0	7	140	180	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	0	6	135	170	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Dec	346	0	6	90	95	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						750	714	713	534	1	1	528	525	510	303	3	0	0
% Total							0.952	0.95067	0.712	0.00133	0.00133		0.99432	0.96591	0.57386	0.00568	0	

1988 Black Creek Escapement Database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chum
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24				0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24				0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24				0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24				0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24				0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24				0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24				0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24				0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24				0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24				0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24				0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24				0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24				0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24				0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	10	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	9	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24	8	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Oct	292	24	9	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24	10	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24	11	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	24	10	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Oct	296	24	10	13	15	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	10	12	10	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24	10	12	10	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24	8	10	5	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	300	24	7	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Oct	301	24	7	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Oct	302	24	8	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24	9	12	10	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24	10	15	15	8	8	8	7	0	0	1	1	1	1	0	0	0
1-Nov	305	24	10	26	75	537	537	532	270	1	0	117	82	82	77	0	0	0
2-Nov	306	24	9	27	75	670	670	668	342	0	0	51	40	40	31	0	0	0
3-Nov	307	24	9	43	140	336	336	334	153	0	0	30	25	25	24	0	0	0
4-Nov	308	24	9	38	100	132	132	132	69	0	0	4	2	2	2	0	0	0
5-Nov	309	10	10	77	150	425	425	56	205	0	0	11	11	4	8	0	0	0
6-Nov	310	14	9	80	160	4	4	4	1	0	0	0	0	0	0	0	0	1
7-Nov	311	24	9	66	140	4	4	4	1	0	0	1	1	1	1	0	0	0
8-Nov	312	24	8	74	160	1	1	1	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24	8	69	167	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	24	8	77	167	2	2	1	0	0	0	0	0	0	0	0	0	0
11-Nov	315	16	7	74	167	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	0	6	92	220	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	317	19	6	82	200	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	318	15	5	72	140	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	5	70	133	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24	6	62	125	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24	6	57	120	1	1	1	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24	5	51	100	2	2	2	1	0	0	0	0	0	0	0	0	0
19-Nov	323	24	6	72	125	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Nov	324	24	5	67	125	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	325	6	7	120	180	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	326	0	6	130	200	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Nov	327	0	6	121	200	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	0	5	98	200	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	0	3	87	200	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	0	3	79	140	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	0	4	82	167	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	0	3	79	167	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	9	4	68	125	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	5	63	125	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	24	4	56	111	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	24	4	54	111	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	24	5	51	100	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	24	6	47	100	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	24	5	45	100	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	15	7	72	167	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	15	7	79	167	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	24	7	76	167	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	12	7	69	143	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	12	7	60	120	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	12	7	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						2122	2122	1743	1049	1	0	215	162	155	144	0	0	1
% Total							1	0.82139	0.49434	0.00047	0		0.75349	0.72093	0.66977	0	0	

1985 Trout River Escapement Database

Date	Calendar	Fence	Temp	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chum
dd-mmm	date	Oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274		13	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24	13	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24	13	4	10	2	2	2	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	12	4	31	7	7	3	0	0	0	3	3	0	0	0	0	0
5-Oct	278	24	12	5	21	14	14	0	0	0	0	1	1	1	0	0	0	0
6-Oct	279	24	13	6	40	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	11	14	18	6	5	5	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	10	78	40	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	10	55	20	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24	10	75	20	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24	10	70	20	8	8	1	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24	10	82	40	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24	10	70	30	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	10	75	30	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	10	76	10	9	7	3	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	10	35	22	13	13	4	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	10	40	43	11	11	2	0	0	0	2	2	0	0	0	0	0
18-Oct	291	24	9	55	33	62	58	15	0	0	0	1	1	0	0	0	0	0
19-Oct	292	8	10	55	80	2	2	0	0	0	0	5	5	0	0	0	0	1
20-Oct	293	24	10	90	30	4	3	3	1	0	0	0	0	0	0	0	0	0
21-Oct	294	5	9	160	30	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	2	9	100	100	3	3	3	0	0	0	0	0	0	0	0	0	1
23-Oct	296	12	8	112	35	38	36	36	2	0	0	0	0	0	0	0	0	0
24-Oct	297	12	10	120	220	31	31	31	0	0	0	5	5	4	0	0	0	0
25-Oct	298	12	9	135	220	25	24	24	1	0	0	0	0	0	0	0	0	0
26-Oct	299	12	8	105	160	14	12	12	2	0	0	1	1	1	0	0	0	0
27-Oct	300	12	8	98	160	19	12	12	0	0	0	0	0	0	0	0	0	0
28-Oct	301	12	7	60	85	3	3	3	0	0	0	1	0	0	1	0	0	3
29-Oct	302	10	6	50	42	1	1	1	0	0	0	1	1	1	0	0	0	2
30-Oct	303	11	6	50	56	19	13	13	0	0	0	1	1	1	0	0	0	0
31-Oct	304	11	6	50	83	3	0	0	0	0	0	2	1	1	1	0	0	0
1-Nov	305	11	8	68	50	4	2	2	0	0	0	0	0	0	0	0	0	0
2-Nov	306	11	8	60	45	7	5	5	1	0	0	0	0	0	0	0	0	4
3-Nov	307	11	7	52	45	2	2	2	0	0	0	2	1	1	1	0	0	0
4-Nov	308	11	6	45	45	4	4	4	0	0	0	1	1	1	0	0	0	1
5-Nov	309	11	6	45	70	2	2	2	0	0	0	2	2	2	0	0	0	0
6-Nov	310	11	6	38	80	0	0	0	0	0	0	3	3	3	0	0	0	2
7-Nov	311	11	6	38	70	1	1	1	0	0	0	0	0	0	0	0	0	2
8-Nov	312	11	6	35	70	1	1	1	0	0	0	2	2	2	0	0	0	8
9-Nov	313	10	3	90	80	2	2	2	0	0	0	2	2	2	0	0	0	0
10-Nov	314	10	2	95	60	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	10	2	75	60	1	1	1	0	0	0	0	0	0	0	0	0	0
12-Nov	316	10	1	40	40	3	3	3	0	0	0	0	0	0	0	0	0	0
13-Nov	317	24	1	70	16	4	4	4	0	0	0	1	1	1	0	0	0	0
14-Nov	318	24	3	30	10	2	2	2	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	3	30	10	2	2	2	0	0	0	1	1	1	0	0	0	1
16-Nov	320	24	3	30	40	0	0	0	0	0	0	0	0	0	0	0	0	8
17-Nov	321	24	3	30	40	1	1	1	0	0	0	0	0	0	0	0	0	2
18-Nov	322	24	1	30	40	0	0	0	0	0	0	3	3	3	0	0	0	0
19-Nov	323	24	2	30	40	0	0	0	0	0	0	0	0	0	0	0	0	1
20-Nov	324	24	2	30	40	0	0	0	0	0	0	0	0	0	0	0	0	1
21-Nov	325	24	0	30	40	0	0	0	0	0	0	0	0	0	0	0	0	3
22-Nov	326	24	0	30	50	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Nov	327	24	0	30	50	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	24	0	30	50	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	24	0	40	10	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	24	0	40	10	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	24	0	45	10	1	1	1	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	0	30	10	4	4	4	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	0	30	10	1	1	1	0	0	0	1	0	0	1	0	0	0
30-Nov	334	24	0	30	22	1	1	1	0	0	0	0	0	0	0	0	0	1
1-Dec	335	24	0	30	23	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	24	0	30	10	0	0	0	0	0	0	0	0	0	0	0	0	1
3-Dec	337	24	1	30	30	113	10	10	1	0	0	0	0	0	0	0	0	2
4-Dec	338	24	1	45	50	0	0	0	0	0	0	0	0	0	0	0	0	65
5-Dec	339	24	1	40	66	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	10	1	40	60	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	16	3	35	120	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	18	3	20	110	2	2	2	0	0	0	0	0	0	0	0	0	0
9-Dec	343	18	2	15	120	2	2	2	0	0	0	0	0	0	0	0	0	1
10-Dec	344	18	2	10	70	2	2	2	0	0	0	0	0	0	0	0	0	0
11-Dec	345	24	1	45	100	1	1	1	0	0	0	1	1	1	0	0	0	0
12-Dec	346	24	1	45	100	2	2	2	0	0	0	0	0	0	0	0	0	2
13-Dec	347	24	1	30	100	0	0	0	0	0	0	0	0	0	0	0	0	5
14-Dec	348	24	1	30	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						459	323	231	8	0	0	42	38	26	4	0	0	117
% Total						1	0.7037	0.50327	0.01743	0	0		0.90476	0.61905	0.09524	0	0	

1986 Trent River Escapement Database

Date dd-mmm	Calendar date	Fence Oper. (h)	Temp. (C.)	Level (cm)	Veloc. (cm/s)	Adults caught	Adults released	Adults marked	Adults no adip.	Adults no L.V	Adults no R.V	Jacks caught	Jacks released	Jacks marked	Jacks no adip.	Jacks no L.V	Jacks no R.V	Chum salmon
1-Oct	274	24	12	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0
2-Oct	275	24	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24	13	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	13	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24	13	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	13	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	13	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	13	4	0	8	8	8	1	5	0	0	0	0	0	0	0	0
10-Oct	283	24	11	4	0	9	9	9	1	7	0	0	0	0	0	0	0	0
11-Oct	284	24	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24	9	1	0	13	13	13	1	8	0	1	1	1	0	0	0	0
14-Oct	287	24	11	1	0	10	10	10	0	7	0	0	0	0	0	0	0	0
15-Oct	288	24	11	2	25	1	1	1	1	0	0	0	0	0	0	0	0	0
16-Oct	289	24	10	5	30	1	1	1	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	11	5	25	1	0	0	0	1	0	1	0	0	0	1	0	0
18-Oct	291	24	11	4	22	4	3	3	0	1	1	0	0	0	0	0	0	0
19-Oct	292	24	11	5	27	1	1	1	0	1	0	0	0	0	0	0	0	0
20-Oct	293	24	11	5	20	1	1	1	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24	11	5	13	0	0	0	0	0	0	1	1	1	0	0	0	0
22-Oct	295	24	11	5	14	1	0	0	0	1	0	0	0	0	0	0	0	0
23-Oct	296	24	11	5	30	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	10	3	20	1	1	1	0	1	0	0	0	0	0	0	0	0
25-Oct	298	24	11	5	26	16	16	16	3	4	0	0	0	0	0	0	0	0
26-Oct	299	23	11	8	58	12	11	11	6	3	0	0	0	0	0	0	0	0
27-Oct	300	24	10	28	88	22	20	20	3	9	0	5	5	5	2	0	1	0
28-Oct	301	24	9	28	76	24	21	21	6	11	0	0	0	0	0	0	0	0
29-Oct	302	24	10	28	75	57	54	54	8	27	0	1	1	1	0	0	0	0
30-Oct	303	24	10	29	75	65	59	58	10	27	0	0	0	0	0	0	0	0
31-Oct	304	24	10	48	150	110	94	94	17	52	0	1	1	1	0	0	0	0
1-Nov	305	24	8	36	95	53	46	46	6	27	0	0	0	0	0	0	0	0
2-Nov	306	24	8	28	100	17	15	15	1	13	0	0	0	0	0	0	0	0
3-Nov	307	24	8	23	76	9	8	8	2	5	0	0	0	0	0	0	0	0
4-Nov	308	24	9	20	83	3	2	2	0	1	0	2	2	2	0	1	0	0
5-Nov	309	24	9	46	45	2	2	2	0	1	0	0	0	0	0	0	0	0
6-Nov	310	24	8	45	45	8	7	7	3	4	0	0	0	0	0	0	0	0
7-Nov	311	24	6	25	43	10	10	10	1	4	0	2	2	2	0	0	0	0
8-Nov	312	24	4	17	40	170	117	117	15	76	0	3	3	3	0	0	0	0
9-Nov	313	24	4	17	40	1	1	1	0	1	0	0	0	0	0	0	0	0
10-Nov	314	24	3	14	80	2	1	1	1	2	0	0	0	0	0	0	0	0
11-Nov	315	24	4	14	75	1	1	1	0	0	0	0	0	0	0	0	0	0
12-Nov	316	24	5	14	75	1	1	1	0	1	0	0	0	0	0	0	0	0
13-Nov	317	24	5	14	80	70	69	69	9	37	0	2	2	2	0	0	0	4
14-Nov	318	24	5	15	75	108	103	101	17	59	0	5	4	4	2	0	0	10
15-Nov	319	24	5	14	55	164	157	157	28	74	0	1	1	1	0	0	0	3
16-Nov	320	24	5	14	55	21	20	20	3	12	0	0	0	0	0	0	0	0
17-Nov	321	24	5	14	55	39	37	37	8	18	0	1	1	1	0	0	0	0
18-Nov	322	12	5	35	83	40	39	39	7	12	0	2	2	2	1	0	0	3
19-Nov	323	10	6	51	300	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Nov	324	0	4	157	400	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	325	0	4	84	300	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	326	12	5	64	150	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Nov	327	0	5	176	500	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	0	4	72	200	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	3	5	65	175	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	0	5	90	400	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	0	5	82	300	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	14	4	62	140	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	3	52	140	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	4	50	125	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	0	4	192	500	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	0	3	76	275	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	12	2	57	90	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	24	2	48	90	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	24	3	38	83	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	24	3	35	90	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	24	3	30	80	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	24	2	24	55	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	24	2	20	40	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	24	1	18	40	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	24	1	18	40	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Dec	346	24	1	18	40	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						1076	959	956	158	512	1	29	26	26	5	2	1	20
% Total							0.89126	0.88848	0.14684	0.47584	0.00093		0.89655	0.89655	0.17241	0.06897	0.03448	

Note: 33 adults had no adip. & no LV

1987 Trent River Escapement Database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jack	Jacks	Jacks	Jacks	Chum
dd-mmm	day	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24				0	0	0	0	0	0	0	1	0	0	0	0	0
2-Oct	275	24				0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24				0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	14	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24	14	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24	13	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	15	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	14	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	14	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24	14	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24	12	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24	13	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24	11	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	10	0	20	1	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	9	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	10	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	9	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24	9	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Oct	292	24	8	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24	8	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24	8	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	24	7	0	17	1	0	0	0	0	0	0	0	0	0	0	0	0
23-Oct	296	24	8	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	9	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24	10	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24	11	2	22	0	0	0	0	0	0	1	1	1	0	0	0	0
27-Oct	300	24	11	2	20	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Oct	301	24	10	1	23	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Oct	302	24	10	1	20	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24	10	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24	11	5	22	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Nov	305	24	10	16	66	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Nov	306	24	9	15	63	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	307	24	10	11	50	0	0	0	0	0	0	1	1	1	0	0	0	0
4-Nov	308	24	10	8	43	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Nov	309	24	10	6	35	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	24	11	6	35	1	1	0	0	0	0	0	0	0	0	0	0	0
7-Nov	311	24	11	8	40	6	1	1	1	0	0	2	0	0	0	0	0	0
8-Nov	312	24	11	9	40	1	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24	11	10	50	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	16	10	98	400	15	15	15	3	1	0	0	0	0	0	0	0	2
11-Nov	315	9	10	56	99	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	24	10	46	75	34	34	34	7	2	0	4	4	4	1	1	0	7
13-Nov	317	24	9	53	99	31	29	29	11	2	0	1	1	1	0	0	0	3
14-Nov	318	24	8	39	120	4	4	4	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	7	39	85	4	4	4	0	0	0	0	0	0	0	0	0	2
16-Nov	320	24	7	35	80	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24	4	32	60	0	0	0	0	0	0	0	0	0	0	0	0	1
18-Nov	322	24	5	26	60	46	11	11	7	4	1	2	2	2	0	0	0	31
19-Nov	323	24	6	26	80	1	1	1	0	0	0	0	0	0	0	0	0	7
20-Nov	324	24	7	29	80	20	20	20	3	3	0	1	1	1	0	0	0	17
21-Nov	325	24	8	59	99	11	9	9	2	1	0	0	0	0	0	0	0	13
22-Nov	326	24	7	76	200	12	9	9	4	2	0	0	0	0	0	0	0	3
23-Nov	327	24	6	54	130	5	5	5	0	0	0	0	0	0	0	0	0	0
24-Nov	328	0	6	56	200	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	0	6	51	180	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	0	6	46	150	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	0	7	43	99	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	14	5	37	60	0	0	0	0	0	0	0	0	0	0	0	0	2
29-Nov	333	24	6	32	33	0	0	0	0	0	0	0	0	0	0	0	0	4
30-Nov	334	24	6	32	33	1	1	1	1	0	0	0	0	0	0	0	0	1
1-Dec	335	0	6	186	300	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	0	6	186	200	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	0	6	136	200	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	0	6	93	200	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	12	6	72	160	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	0	5	136	200	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	10	5	73	175	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	0	6	148	220	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	0	6	126	200	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	0	6	106	150	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	0	5	86	130	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						194	144	143	39	15	1	12	11	10	1	1	0	93
% Total							0.74227	0.73711	0.20103	0.07732	0.00515		0.91667	0.83333	0.08333	0.08333	0	

Note: 2 adults had no adip. & no L.V

1988 Tess River Escapement Database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jack	Jacks	Jacks	Jacks	Chum
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24	13	5	20	2	2	2	2	1	0	1	1	1	1	0	0	0
2-Oct	275	24	14	5	20	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24	12	4	15	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	12	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24	13	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24	12	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	12	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	11	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	11	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24	11	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24	10	0	10	1	0	0	0	1	0	0	0	0	0	0	0	0
12-Oct	285	24	13	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24	13	2	36	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	12	8	58	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	12	11	23	1	1	1	1	0	0	0	0	0	0	0	0	0
16-Oct	289	24	12	31	125	39	39	39	17	9	3	10	10	10	4	0	0	0
17-Oct	290	24	9	19	90	5	5	5	1	0	0	0	0	0	0	0	0	0
18-Oct	291	24	9	15	55	4	4	4	1	0	0	2	2	2	0	0	0	0
19-Oct	292	24	9	17	62	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24	10	16	65	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24	10	15	58	8	8	8	5	1	0	1	1	1	0	0	0	1
22-Oct	295	24	10	13	50	5	5	5	1	0	0	3	3	3	1	0	0	1
23-Oct	296	24	10	13	50	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	10	12	56	2	2	2	0	1	0	0	0	0	0	0	0	0
25-Oct	298	24	9	12	55	214	173	170	84	27	1	87	87	84	24	0	0	4
26-Oct	299	24	8	11	50	4	4	4	3	1	0	1	1	1	0	0	0	0
27-Oct	300	24	8	8	33	4	4	4	1	1	0	2	2	2	1	0	0	0
28-Oct	301	24	8	8	33	1	0	0	1	1	0	0	0	0	0	0	0	0
29-Oct	302	24	7	8	33	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24	8	26	83	20	20	20	8	3	0	1	1	1	0	1	0	0
31-Oct	304	17	8	30	99	52	52	52	28	15	0	7	7	7	3	0	0	0
1-Nov	305	0	8	133	250	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Nov	306	0	7	73	100	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	307	0	7	83	150	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Nov	308	0	6	83	150	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Nov	309	0	6	183	350	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	0	6	133	250	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Nov	311	0	5	78	150	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Nov	312	0	5	69	125	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	0	7	58	90	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	0	7	78	120	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	13	7	58	100	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	0	6	91	170	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	317	12	6	56	100	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	318	24	5	44	110	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	5	41	100	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24	7	36	75	3	3	3	0	0	0	0	0	0	0	0	0	8
17-Nov	321	24	6	39	100	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24	4	36	83	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	323	18	6	41	100	1	1	1	0	0	0	0	0	0	0	0	0	1
20-Nov	324	16	5	68	130	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	325	0	5	153	250	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	326	0	5	153	250	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Nov	327	0	5	88	200	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	11	5	62	125	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	24	4	51	99	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	24	4	41	66	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	24	4	50	120	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	4	46	90	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	4	43	70	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	5	38	71	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	24	4	35	67	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	24	4	58	100	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	24	3	48	75	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	24	3	45	75	1	1	1	0	0	0	0	0	0	0	0	0	0
5-Dec	339	24	3	52	95	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	24	6	87	120	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	24	6	68	99	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	24	7	54	85	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	24	6	48	75	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	12	6	48	75	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	OUT																
Total						367	324	321	153	61	4	115	115	112	34	1	0	15
% Total							0.88283	0.87466	0.41689	0.16621	0.0109		1	0.97391	0.29565	0.0087	0	

Note: 40 adults w/ no adip. & no L.V.
1 adult w/ no adip. & no R.V.

1985 French Creek escapement database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chums
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24	6	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24	7	8	14	4	4	4	0	0	0	4	4	4	0	0	0	0
13-Oct	286	24	6	7	10	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	10	6	9	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	10	6	8	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	10	6	8	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	10	10	13	1	1	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24	10	9	13	1	1	0	0	0	0	1	1	0	0	0	0	0
19-Oct	292	24	10	12	16	127	124	35	0	0	0	25	25	2	0	0	0	0
20-Oct	293	24	10	12	40	243	236	46	0	0	0	12	12	0	0	0	0	0
21-Oct	294	24	10	10	37	186	186	27	0	0	0	1	1	1	0	0	0	1
22-Oct	295	7	10	20	71	3	3	1	0	0	0	0	0	0	0	0	0	1
23-Oct	296	17	10	12	50	2	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	10	9	66	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24	10	8	50	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24	7	7	33	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	300	24	8	13	37	2	2	1	0	0	0	0	0	0	0	0	0	0
28-Oct	301	24	7	11	33	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Oct	302	24	6	10	33	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24	7	9	40	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24	6	11	33	1	1	0	0	0	0	0	0	0	0	0	0	0
1-Nov	305	24	8	11	40	15	3	3	0	0	0	2	2	1	0	0	0	1
2-Nov	306	24	8	11	40	11	3	3	0	0	0	0	0	0	0	0	0	0
3-Nov	307	24	8	10	33	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Nov	308	24	7	8	50	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Nov	309	24	6	7	30	51	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	24	6	9	20	0	0	0	0	0	0	1	1	1	0	0	0	0
7-Nov	311	24	6	13	21	1	1	1	0	0	0	0	0	0	0	0	0	0
8-Nov	312	24	6	12	22	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24	5	12	22	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	24	3	13	23	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	24	2	13	23	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	24	1	10	16	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	317	24	1	10	17	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	318	24	2	10	16	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	4	12	20	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24	3	16	25	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24	2	17	27	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24	1	16	20	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	323	24	1	13	24	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Nov	324	24	1	13	23	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	325	24	0	11	19	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	326	24	0	10	13	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Nov	327	24	0	9	10	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	24	0	7	10	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	24	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	4	1	19	75	3	2	1	0	0	0	0	0	0	0	0	0	3
6-Dec	340	0	1	20	75	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	12	2	15	50	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	24	3	15	50	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	24	2	13	50	7	3	3	0	0	0	0	0	0	0	0	0	0
10-Dec	344	24	1	11	40	1	1	1	0	0	0	0	0	0	0	0	0	0
11-Dec	345	24	1	9	33	0	0	0	0	0	0	0	0	0	0	0	0	1
12-Dec	346	24	1	13	30	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Dec	347	24	1	11	25	2	0	0	0	0	0	0	0	0	0	0	0	0
14-Dec	348	24	2	10	25	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						661	571	126	0	0	0	46	46	9	0	0	0	7
% Total							0.86384	0.19062	0	0	0		1	0.19565	0	0	0	

1986 French Creek escapement database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chums
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	captured	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24	11	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Oct	292	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	24	10	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Oct	296	24	10	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	10	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24	10	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24	10	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	300	24	10	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Oct	301	24	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Oct	302	24	10	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24	10	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Nov	305	24	9	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Nov	306	24	9	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	307	24	9	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Nov	308	24	9	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Nov	309	24	9	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	24	7	9	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Nov	311	24	7	9	10	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Nov	312	24	6	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24	6	6	10	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	24	5	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	24	5	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	24	6	7	20	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	317	24	6	7	20	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	318	24	6	11	20	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	6	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24	6	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24	5	8	20	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24	6	14	40	418	377	327	0	1	0	25	23	23	6	4	0	0
19-Nov	323	24	6	33	50	180	161	161	0	0	0	1	1	1	0	0	0	0
20-Nov	324	0	6	56	100	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	325	15	6	40	60	5	5	5	0	0	0	0	0	0	0	0	0	0
22-Nov	326	24	6	33	55	0	0	0	0	0	0	0	0	0	0	0	0	2
23-Nov	327	24	8	50	150	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	24	7	42	100	5	5	5	0	1	1	0	0	0	0	0	0	0
25-Nov	329	16	7	33	60	4	4	4	0	0	0	0	0	0	0	0	0	1
26-Nov	330	0	7	53	50	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	16	6	41	120	1	1	1	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	5	36	63	2	2	2	0	0	0	0	0	0	0	0	0	1
29-Nov	333	24	5	32	47	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	5	29	45	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	20	6	54	150	3	3	3	0	1	0	0	0	0	0	0	0	0
2-Dec	336	24	5	40	100	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	24	4	34	70	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	24	4	29	60	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	24	4	29	60	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	24	4	27	50	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	24	5	26	40	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	24	4	20	40	0	0	0	0	0	0	0	0	0	0	0	0	1
9-Dec	343	24	3	24	30	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	24	3	24	30	7	0	0	0	1	0	0	0	0	0	0	0	0
11-Dec	345	24	3	24	30	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Dec	346	24	5	27	50	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Dec	347	24	5	27	50	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Dec	348	24	5	27	60	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						625	558	508	0	4	1	26	24	24	6	4	0	5
% Total							0.8928	0.8128	0	0.0064	0.0016		0.92308	0.92308	0.23077	0.15385	0	

							1987 French Creek escapement database												
Date	Calendar	Passe	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Jacks	Chum
dd-mmm	date	oper. (h)	(C.)	(cm)	(cm/s)	captured	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	no R.V	salmon
1-Oct	274	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	275	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	276	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	277	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Oct	278	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	279	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	280	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Oct	281	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	282	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Oct	283	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Oct	284	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	285	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Oct	286	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Oct	291	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Oct	292	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	293	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	294	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Oct	296	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	300	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Oct	301	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Oct	302	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	303	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Nov	305	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Nov	306	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	307	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Nov	308	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Nov	309	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	310	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Nov	311	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Nov	312	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	314	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	317	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	318	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	323	24	8	6	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Nov	324	24	8	6	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	325	24	8	13	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	326	24	6	24	100	40	30	30	21	2	0	53	53	53	45	1	0	0	0
23-Nov	327	6	8	62	110	18	14	14	5	1	0	32	32	32	28	6	0	0	0
24-Nov	328	14	6	46	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	24	7	38	50	2	2	2	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	24	6	32	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	24	9	28	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	6	27	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	8	25	17	14	11	0	6	1	0	4	4	0	3	0	0	3	0
30-Nov	334	7	6	71	260	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	0	6	63	210	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	0	7	58	180	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	14	6	51	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	22	6	46	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	0	6	71	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	0	6	61	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	16	6	54	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	12	6	65	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	0	6	82	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Dec	344	0	5	61	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	345	0	5	45	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total						76	57	46	32	4	0	89	89	85	76	7	0	3	
% Total							0.75	0.60526	0.42105	0.05263	0		1	0.95506	0.85393	0.07865	0		

1988 French Creek escapement database

Date	Calendar	Fence	Temp.	Level	Veloc.	Adults	Adults	Adults	Adults	Adults	Adults	Jacks	Jacks	Jack	Jacks	Jacks	Jacks	Chum
dd-mmm	Date	oper. (h)	(C.)	(cm)	(cm/s)	caught	released	marked	no adip.	no L.V	no R.V	caught	released	marked	no adip.	no L.V	no R.V	salmon
1-Oct	274	24																
2-Oct	275	24																
3-Oct	276	24																
4-Oct	277	24																
5-Oct	278	24																
6-Oct	279	24																
7-Oct	280	24																
8-Oct	281	24																
9-Oct	282	24																
10-Oct	283	24																
11-Oct	284	24																
12-Oct	285	24																
13-Oct	286	24	11	6	16	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	287	24	11	8	10	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	288	24	12	7	11	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Oct	289	24	12	8	14	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Oct	290	24	9	10	19	1	1	1	1	0	0	0	0	0	0	0	0	0
18-Oct	291	24	9	10	22	1	1	1	1	0	0	0	0	0	0	0	0	0
19-Oct	292	24	9	11	21	4	4	4	4	0	0	3	3	3	3	0	0	0
20-Oct	293	24	10	12	25	1	1	1	1	0	0	0	0	0	0	0	0	0
21-Oct	294	24	11	11	18	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	295	24	10	10	17	1	1	1	0	0	0	0	0	0	0	0	0	0
23-Oct	296	24	11	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Oct	297	24	10	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Oct	298	24	9	10	18	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	299	24	9	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	300	24	11	7	20	5	4	4	4	0	0	0	0	0	0	0	0	0
28-Oct	301	24	6	9	20	3	2	2	2	0	0	0	0	0	0	0	0	0
29-Oct	302	24	6	9	15	2	2	2	2	0	0	0	0	0	0	0	0	0
30-Oct	303	24	6	9	18	1	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	304	24	9	27	25	35	25	25	19	0	0	4	4	4	3	0	0	0
1-Nov	305	24	9	28	50	396	361	359	257	5	0	71	71	70	60	0	0	0
2-Nov	306	24	9	32	125	233	217	216	124	4	0	16	16	16	14	2	0	0
3-Nov	307	24	9	59	130	192	182	182	106	0	1	13	13	13	13	0	0	0
4-Nov	308	24	9	52	85	57	47	47	26	0	0	2	2	2	2	0	0	1
5-Nov	309	8	9	67	60	2	2	2	1	0	0	0	0	0	0	0	0	0
6-Nov	310	0	8	70	150	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Nov	311	5	8	49	125	2	2	2	0	0	0	0	0	0	0	0	0	0
8-Nov	312	24	8	44	99	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	313	24	8	40	76	1	1	1	0	0	0	0	0	0	0	0	0	0
10-Nov	314	24	8	40	71	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Nov	315	23	6	60	52	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	316	0	6	61	125	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	317	15	6	49	91	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	318	24	5	43	91	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	319	24	6	39	67	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	320	24	7	36	50	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	321	24	7	34	23	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	322	24	5	31	34	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	323	24	6	34	28	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Nov	324	24	7	44	83	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	325	23	7	51	125	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	326	0	7	78	150	0	0	0	0	0	0	0	0	0	0	0	0	2
23-Nov	327	0	7	72	167	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov	328	0	5	56	125	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	329	22	5	50	77	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	330	24	4	44	83	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	331	24	5	42	71	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Nov	332	24	5	46	111	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Nov	333	24	6	42	71	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	334	24	6	40	67	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Dec	335	24	5	37	59	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Dec	336	24	5	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Dec	337	24	6	45	77	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec	338	24	6	41	91	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	339	24	7	39	83	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	340	24	8	40	71	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Dec	341	24	8	45	63	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Dec	342	24	8	42	56	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Dec	343	OUT																
10-Dec	344																	
11-Dec	345																	
Total						937	853	850	548	9	1	109	109	108	95	2	0	3
% Total							0.91035	0.90715	0.58485	0.00961	0.00107		1	0.99083	0.87156	0.01835	0	

Note: 8 adults w/ no adip. & no L.V.